DOCUMENT RESUME

ED 363 542 SO 023 369

AUTHOR Subbarao, K.; Raney, Laura
TITLE Social Gains from Female Education: A Cross-National Study. World Bank Discussion Papers 194.
INSTITUTION World Bank, Washington, D. C.
REPORT NO ISBN-0-8213-2387-3; ISSN-0259-210X
PUB DATE Mar 93
NOTE 75p.
AVAILABLE FROM Distribution Unit, Office of the Publisher, Department F, the World Bank, 1818 H St., N.W., Washington, DC 20433; Publications, The World Bank, 66, avenue d'Iena, 75116, Paris, France.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Birth Rate; Cross Cultural Studies; Developing Nations; Economic Impact; Family Planning; *Females; Health Programs; *Human Capital; Outcomes of Education; *Productivity; *Role of Education; *Secondary Education; Social Science Research; *Womens Education

ABSTRACT

This paper on the social gains from female education is part of a series, prepared by the World Bank, on the benefits of improving opportunities for women. The paper suggests that expanding women's opportunities enhances their productivity and earning potential and thus contributes to better economic performance and poverty alleviation. Education raises the productivity and earnings of both men and women. Over time female education also contributes to slower population growth and healthier families. The Bank believes that in efforts to expand women's opportunities, priority should be given to education through the secondary level, reproductive health, agriculture, private entrepreneurship, and the wage labor force. This paper is concerned with the estimation of these social gains from female education at the secondary level. The paper examines the role of female education, measured by gross enrollment rates at the secondary level, relative to, and or in combination with, some health and family planning services that influence fertility and infant mortality. It uses reduced form estimation of the total fertility rate and infant mortality rate. The paper presents cross country regressions based on data drawn from 72 developing countries. The analysis in this paper generally shows that female secondary education, family planning, and health programs all affect fertility and mortality, and the effect of female secondary education appears to be very strong. Results suggest that family planning will reduce fertility more when combined with female education, especially in countries that now have low female secondary enrollment levels. (DK)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 363 542

50

World Bank Discussion Papers

Social Gains from Female Education

A Cross-National Study

K. Subbarao
Laura Raney

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it
Minor changes have been made to improve reproduction quality
Points of view or opinions stated in this document do not necessarily represent official OERI position or policy

"PERMISSION TO REPRODUCE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY
J. FEATHER
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SO 023 369

BEST COPY AVAILABLE

Recent World Bank Discussion Papers

No. 134 *Forest Economics and Policy Analysis: An Overview*. William F. Hyde and David H. Newman, with a contribution by Roger A. Sedjo

No. 135 *A Strategy for Fisheries Development*. Eduardo Loayza, in collaboration with Lucian M. Sprague

No. 136 *Strengthening Public Service Accountability: A Conceptual Framework*. Samuel Paul

No. 137 *Deferred Cost Recovery for Higher Education: Student Loan Programs in Developing Countries*. Douglas Albrecht and Adrian Ziderman

No. 138 *Coal Pricing in China: Issues and Reform Strategy*. Yves Albouy

No. 139 *Portfolio Performance of Selected Social Security Institutes in Latin America*. Carmelo Mesa-Lago

No. 140 *Social Security and Prospects for Equity in Latin America*. Carmelo Mesa-Lago

No. 141 *China's Foreign Trade and Comparative Advantage: Prospects, Problems, and Policy Implications*. Alexander J. Yeats

No. 142 *Restructuring Socialist Industry: Poland's Experience in 1990*. Homi J. Kharas

No. 143 *China: Industrial Policies for an Economy in Transition*. Inderjit Singh

No. 144 *Reforming Prices: The Experience of China, Hungary, and Poland*. Anand Rajaram

No. 145 *Developing Mongolia*. Shahid Yusuf and Shahid Javed Burki

No. 146 *Sino-Japanese Economic Relationships: Trade, Direct Investment, and Future Strategy*. Shuichi Ono

No. 147 *The Effects of Economic Policies on African Agriculture: From Past Harm to Future Hope*. William K. Jaeger

No. 148 *The Sectoral Foundations of China's Development*. Shahid Javed Burki and Shahid Yusuf, editors

No. 149 *The Consulting Profession in Developing Countries: A Strategy for Development*. Syed S. Kirmani and Warren C. Baum

No. 150 *Successful Rural Finance Institutions*. Jacob Yaron

No. 151 *Transport Development in Southern China*. Clell G. Harral, editor, and Peter Cook and Edward Holland, principal contributors

No. 152 *The Urban Environment and Population Relocation*. Michael M. Cernea

No. 153 *Funding Mechanisms for Higher Education: Financing for Stability, Efficiency, and Responsiveness*. Douglas Albrecht and Adrian Ziderman

No. 154 *Earnings, Occupational Choice, and Mobility in Segmented Labor Markets of India*. Shahidur R. Khandker

No. 155 *Managing External Debt in Developing Countries: Proceedings of a Joint Seminar, Jeddah, May 1990*. Thomas M. Klein, editor

No. 156 *Developing Agricultural Extension for Women Farmers*. Katrine A. Saito and Daphne Spurling

No. 157 *Awakening the Market: Viet Nam's Economic Transition*. D. M. Leipziger

No. 158 *Wage Policy during the Transition to a Market Economy: Poland 1990–91*. Fabrizio Coricelli and Ana Revenga, editors

No. 159 *International Trade and the Environment*. Patrick Low, editor

No. 160 *International Migration and International Trade*. Sharon Stanton Russell and Michael S. Teitelbaum

No. 161 *Civil Service Reform and the World Bank*. Barbara Nunberg and John Nellis

No. 162 *Rural Enterprise Development in China, 1986–90*. Anthony J. Ody

No. 163 *The Balance between Public and Private Sector Activities in the Delivery of Livestock Services*. Dina L. Umali, Gershon Feder, and Cornelis de Haan

(Continued on the inside back cover.)

World Bank Discussion Papers

Social Gains from Female Education

A Cross-National Study

K. Subbarao
Laura Raney

The World Bank
Washington, D.C.

Copyright © 1993
The International Bank for Reconstruction
and Development/THE WORLD BANK
1818 H Street, N.W.
Washington, D.C. 20433, U.S.A.

All rights reserved
Manufactured in the United States of America
First printing March 1993

Discussion Papers present results of country analysis or research that is circulated to encourage discussion and comment within the development community. To present these results with the least possible delay, the typescript of this paper has not been prepared in accordance with the procedures appropriate to formal printed texts, and the World Bank accepts no responsibility for errors.

The findings, interpretations, and conclusions expressed in this paper are entirely those of the author(s) and should not be attributed in any manner to the World Bank, to its affiliated organizations, or to members of its Board of Executive Directors or the countries they represent. The World Bank does not guarantee the accuracy of the data included in this publication and accepts no responsibility whatsoever for any consequence of their use. Any maps that accompany the text have been prepared solely for the convenience of readers; the designations and presentation of material in them do not imply the expression of any opinion whatsoever on the part of the World Bank, its affiliates, or its Board or member countries concerning the legal status of any country, territory, city, or area or of the authorities thereof or concerning the delimitation of its boundaries or its national affiliation.

The material in this publication is copyrighted. Requests for permission to reproduce portions of it should be sent to the Office of the Publisher at the address shown in the copyright notice above. The World Bank encourages dissemination of its work and will normally give permission promptly and, when the reproduction is for noncommercial purposes, without asking a fee. Permission to copy portions for classroom use is granted through the Copyright Clearance Center, 27 Congress Street, Salem, Massachusetts 01970, U.S.A.

The complete backlist of publications from the World Bank is shown in the annual *Index of Publications*, which contains an alphabetical title list (with full ordering information) and indexes of subjects, authors, and countries and regions. The latest edition is available free of charge from the Distribution Unit, Office of the Publisher, Department F, The World Bank, 1818 H Street, N.W., Washington, D.C. 20433, U.S.A., or from Publications, The World Bank, 66, avenue d'Iéna, 75116 Paris, France.

ISSN: 0259-210X

K. Subbarao is senior economist in, and Laura Raney is a consultant to, the World Bank's Education and Social Policy Department.

Library of Congress Cataloging-in-Publication Data

Subbarao, K.
Social gains from female education : a cross-national study / K. Subbarao and Laura Raney.
p. cm. — (World Bank discussion papers ; 194)
Includes bibliographical references (p.).
ISBN 0-8213-2387-3
1. Women—Education, Secondary—Social aspects—Developing countries. 2. Women—Education, Secondary—Economic aspects—Developing countries. 3. Fertility, Human—Developing countries. 4. Developing countries—Statistics, Vital. 5. Economic development—Effect of education on. I. Raney, Laura, 1964– . II. Title. III. Series.
LC2527.S83 1993
376'63'091724—dc20 93-6970
CIP

FOREWORD

Expanding women's opportunities enhances their productivity and earning potential and thus contributes to better economic performance and poverty alleviation. Education raises the productivity and earnings of both men and women. Over time female education also contributes to slower population growth and healthier families. The Bank believes that in efforts to expand women's opportunities, priority should be given to education through the secondary level, reproductive health, agriculture, private entrepreneurship and the wage labor force.

The Women in Development Division is preparing a series of papers on the benefits from improving opportunities for women. This paper on the social gains from female education is a part of the series. It is intended to guide the World Bank and also help governments and other development agencies. The series complements other policy work in the Women in Development Division on the benefits from investing in women, and on effective approaches to improving their productivity and earnings.

Ann O. Hamilton
Director
Population and Human Resources Department

ACKNOWLEDGEMENT

For excellent advice and contributions at all stages in the preparation of this study, we are grateful to Barbara Herz. Comments from participants of a PHR workshop where preliminary results of this study were presented were very helpful. We also wish to thank Randy Bulatao, Susan Cochrane, Dennis de Tray, Elizabeth King, Frances Plunkett, Lant Pritchett, Agnes Quisumbing, Martin Ravallion, Guilherme Sedlacek, and Roger Slade, for comments and suggestions. Of course responsibility for the present paper is ours.

Table of Contents

Summary vii

1. Introduction 1

2. Analytical Framework and the Reduced Form Equations 2

   A. Analytical Framework 2
   B. Reduced Form Equations and the Estimation Procedures 5

3. Definitions and Data Sources 8

4. Results and Discussion 10

   A. Education, Family Planning Services and Fertility 10
   B. Female Education, Desired Family Size and Contraceptive Prevalence 19
   C. Female Education, Access to Medical Care, and Child Health 25

5. Quantifying the Gains in Fertility and Mortality Reduction: Some Simulations 32

6. Implications for Policy and Concluding Remarks 36

References 38

Tables

Table 1. Female Education, Family Planning Services and Total Fertility Rate 12

Table 2. Female Education, GDP per capita and Desired Family Size 23

Table 3. Female Education, GDP per capita and Contraceptive Prevalence 23

Table 4. Infant Mortality (1985), Female Education and Program Variables 27

Table 5. Gains in Births Averted through Female Education and Family Planning Program Services: Simulation Results 33

Table 6. Gains in Infant Deaths Averted through Female Education versus Health Services and GDP per capita change: Simulation Results 35

Figures

Figure 1. Elasticities of TFR 1985, with respect to Female Secondary Enrollments, 1970 and FP Services, 1982 14

Figure 2.	Elasticities of TFR with respect to Female Secondary Education, 1975 and FP Services, 1982	17
Figure 3.	Predicted TFR, 1985 for Different Levels of Female Education, 1975 and FP Services, 1982	18
Figure 4.	Total and Desired Fertility	20
Figure 5.	Female Secondary Enrollment, Contraceptive Prevalence and TFR, 1988	21
Figure 6.	Elasticities of Contraceptive Prevalence with respect to Female Enrollments, 1978, FP Services and GDP pc	24
Figure 7a.	Elasticities of IMR, 1985 with respect to Female Secondary Enrollment, 1975 and GDP, 1985	28
Figure 7b.	Elasticities of IMR, 1985 with respect to Population per Physician, 1984	28
Figure 8a.	Predicted IMR, 1985 for different levels of Female Secondary Enrollment, 1975 & GDP pc, 1985	30
Figure 8b.	Predicted IMR, 1985 for different levels of Population per Physician, 1984	30
Figure 9.	Predicted TFR and Infant Survival Rates at different levels of Female Secondary Enrollment in 1975	31

Appendices

Table A1.	List of Sample Countries	41
Table A2.	Variables and Definitions	42
Table A3.	TFR Equations - Means of Standard Deviations	43
Table A4.	IMR Equations - Means of Standard Deviations	43
Table A5.	Education, Family Planning Services, and Total Fertility Rate	44
Table A6.	Elasticities of TFR with respect to Female Secondary Enrollment and Family Planning Services at Different Levels of Enrollments, and Service	45
Table A7.	Female Education, GDP per capita, Desired Family Size, and Contraceptive Prevalence	46
Table A8	Elasticities of Contraceptive Prevalence, with respect to Female Secondary School Enrollment Rate, Access to Family Planning Services, and GDP per capita, at Different Levels of Enrollment, Access and Income	47
Table A9	Elasticities of IMR with respect to Female Secondary Enrollments, Population per Physician, and GDP at Different Levels of Enrollment, 1975	47
Table A10	Education, Program Variables and Infant Mortality	48
Table A11	Infant Mortality (1985), Female Education and Program Variables, including Immunization	49

SUMMARY

i. Female education increases the value of women's time in economic activities by raising labor productivity and wages (with a consequential rise in household incomes and a reduction in poverty). Female education also produces social gains, by improving health (the woman's own health and the health of her children), increasing child schooling, and reducing fertility. This paper is concerned with the estimation of these social gains from female education at the secondary level, as considerable work has already demonstrated effects at the primary level. The paper examines the role of female education (measured by gross enrollment rates at the secondary level) relative to, and or/in combination with, some health and family planning services that influence fertility and infant mortality. It uses reduced-form estimation of the total fertility rate (TFR) and infant mortality rate (IMR). The paper presents cross-country regressions based on data drawn from 72 developing countries. The results from these cross-country regressions should be interpreted cautiously as they may not be representative of a particular country's experience and reflect the usual problems of relying on national averages. Moreover, the aggregate measures of education, health, and family planning available to us provide little information on the specific kinds or quality of services. However, the results are broadly consistent with evidence using household data sets (see e.g. an overview by Schultz 1989, an overview by Cochrane et al 1980, and studies by Gertler and Molineaux 1972; Rosenzweig and Schultz 1987; and Schultz 1988, 1990).

ii. The analysis in this paper generally shows that female secondary education, family planning, and health programs all affect fertility and mortality, and the effect of female secondary education appears to be very strong. Moreover, our results suggest that family planning will reduce fertility more when combined with female education, especially in countries that now have low female secondary enrollment levels. The elasticities of fertility and infant mortality with respect to female education are large and substantially exceed those with respect to family planning and health programs when the elasticities are estimated with appropriate controls. Simulations in the paper were based on our

equation using gross enrollment rates for secondary education from 1975, which we consider a more plausible scenario than with 1970 enrollment rates. In this equation, family planning is significant when interacted with female secondary education. Thus, the effect of family planning should be evaluated with reference to specific education levels. The simulations suggest that a ceteris paribus doubling of female secondary enrollments (from the mean of 19 percent to 38 percent) in 1975 would have reduced the total fertility rate (TFR) in 1985 from 5.3 to 3.9, and a ceteris paribus doubling of the "family planning service score" (from 25 percent to 50 percent) in 1982 would have reduced the TFR in 1985 from 5.5 to 5.0. The implications of female secondary education for reducing the infant mortality rate (IMR) are also striking. A doubling of female secondary enrollments in 1975 from the mean of 19 percent to 38 percent would have reduced the IMR from 81 to 38; halving the ratio of population per physician would have reduced the IMR from 85 to 81. A doubling of GDP per capita from $650 to the median level of $1300 would have reduced IMR from 98 to 92.

iii. Simulations were also done to compare the differences in the quantitative magnitudes of the gains (in terms of births and deaths averted) from female secondary education with the gains from expansion of family planning and some health program efforts to reduce fertility and infant mortality. Doubling female secondary school enrollments from 19 percent to 38 percent in 1975, keeping all other variables (including family planning services) constant at their mean values, would have lowered the number of births by 29 percent compared to the actual number in 1985. Doubling family planning services, holding female secondary enrollment constant at the mean, would have reduced the number of births by 3.5 percent. Simulations show that the gains from female education are also striking in terms of deaths averted. Doubling secondary female education reduces infant deaths by 64 percent; halving the ratio of population per physician reduces the number of infant deaths by 2.5 percent, whereas a doubling of GDP per capita from $ 650 to the median level of $ 1300 would have no effect on reducing infant deaths, keeping all other factors constant.

iv. Female education influences fertility and mortality through many pathways. For example, education affects desired family size by enhancing the opportunity cost of a woman's time in economic activities relative to child-bearing and by changing her aspirations, thus building demand for family planning services. Maternal education promotes child health which in turn affects desired family size. Education also promotes more effective contraceptive use and more willingness to use modern contraceptive methods -- which is, we believe, why we find that education and family planning interact in our TFR equation. Exploring these pathways is important from a policy perspective. Yet the limitations of data and estimation methods prevent us from attempting a detailed analysis of the relative importance of the various pathways. A limited attempt was made to examine the determinants of desired family size for a small sample of 37 countries for which data were available. After controlling for other key factors (such as the level of economic development of a country), female secondary education retains its high statistical significance. However, "desired family size" is a subjective concept, so most researchers rely more on estimates of TFRs observed directly. Among the determinants of contraceptive use, female secondary education and the family planning service score are each highly significant.

v. Future research could usefully ask how the marginal gains from female education, family planning, and health programs at different stages of development and in different combinations compare with marginal costs, once cost data become available for female secondary schooling and for health and family planning program interventions for different countries. Research should also address appropriate phasing of different combinations of education, health, and family planning programs. In so doing, much more information should be developed on different specific kinds of education, health and family planning services that might be made available, so that more precise program strategies can be developed. Specific attention should go to determining the most effective combinations of education, health, and family planning to take advantage of program synergies.

1. Introduction

1.1 Female education increases the value of women's time in economic activities by raising labor productivity and wages (with a consequential rise in household incomes and a reduction in poverty). Female education also produces social gains, by improving health (the woman's own health and the health of her children), increasing child schooling, and reducing fertility. This paper is concerned with the estimation of these social gains from secondary female education (measured as gross enrollment rates). That female education contributes to lower fertility and infant and child mortality is well-known. However, the extent to which female education interacts with health and family planning programs and policies is less well-known. This paper examines the role of secondary female education relative to, and/or in combination with, health and family planning programs and policies that reduce fertility and infant mortality. To the extent the data permit, the paper also explores some of the routes through which female education lowers fertility and mortality, for instance by reducing desired family size or by promoting more effective use of available services for contraception. The paper is based on cross-country data from 72 developing countries (accounting for over 95 percent of the population of developing countries), drawn from the World Bank and other data sources. The period of investigation is 1970-85. The analysis generally shows that female secondary education, family planning, and health programs all affect fertility and mortality, and the effect of female secondary education appears to be very strong. Moreover, our results suggest that family planning will reduce fertility more when combined with female education, especially in countries that now have low female secondary enrollment levels. The elasticities of fertility and infant mortality with respect to female education substantially exceed those with respect to family planning and health programs when the elasticities are estimated with appropriate controls. The results from these cross-country regressions should be interpreted cautiously as they may not be representative of a particular country's experience and reflect the usual problems of relying on national averages. Although endogeneity of services may be less of a problem in cross-country data, using cross-

country data imposes a common structure on the econometric relationship between the variables. However, the results are broadly similar to a number of micro studies (e.g. see Schultz 1989 for a review) and with another cross-country study, Mauldin and Ross (1991) which found that the direct effect of family planning effort is less than the total (direct and indirect effects) of socio-economic factors (including education).

1.2 The paper is organized as follows. The basic analytical framework and the models to be tested are described in Section 2. Definitions, data sources, and limitations are discussed briefly in Section 3. The results from cross-country equations are discussed in Section 4. Some policy simulations are attempted in Section 5. Last, the concluding section draws some inferences for policy.

2. Analytical Framework and the Reduced Form Equations

A. Analytical Framework

2.1 For most couples, achieving a pregnancy does not require a deliberate decision, but avoiding a pregnancy does. Following Herz (1984), this section outlines a structural framework focusing on the factors determining the number of children parents want and their ability to limit births to that number, with particular reference to the role of female education in influencing parental decisions and abilities.

2.2 The total fertility rate (TFR) -- the number of children that would be born to a woman if she lives to the end of her childbearing years and bears children at each age in accordance with the prevailing age-specific fertility rates -- comprises the number of children parents want (desired family

size, or DFS) plus unintended births (which depend on parents' ability to achieve desired family size). In economic terms, DFS thus represents the demand for children by parents. DFS depends mainly on female education, male education, the insurance value of children, and the demand for female labor in the wage labor market, which may be reflected in the country's level of development (and proxied by the per capita GDP). DFS also reflects the chances for child survival.

2.3 Child survival depends in turn on the mother's education and on other factors such as access to safe drinking water, access to health services including immunization and curative care for common childhood diseases, and access to family planning (which promotes healthier spacing of births).

2.4 Of course, parents may have more or fewer children than they desire. This paper focuses on the more usual case where couples could have more children than they desire if they took no steps to limit pregnancy. The ability to achieve desired family size depends on the availability of family planning services, but also on other factors such as the age at marriage or union, duration of breastfeeding, and the scope for abortion.

2.5 These structural relationships suggest many pathways through which female education and family planning services affect fertility. Education, especially of the mother, works through wage and productivity effects on the opportunity cost of the mother's time and thus affects desired family size. It also improves the chances of child survival and so indirectly affects desired family size. Finally, education builds ability as well as willingness to use the available modern methods of contraception effectively and thus helps people achieve their desired family size. Family planning services enable couples more readily to achieve (lower) desired family size and over time may influence desired family size itself by affecting infant deaths (and perhaps also social norms).

2.6 From a policy perspective, it would be valuable to know more about the relative importance of the many pathways through which female education and family planning program services influence fertility. But such a structural model is extremely difficult to estimate because of data and econometric limitations. First and most important, DFS cannot be observed objectively. It is essentially an opinion, and people's responses may be influenced by the number of children they already have. Many a couple may be reluctant to say they did not want the children they already have. Second, country-level data sources are often not suitable for comparison as the type of canvassing and questions asked of the respondents do not always match. Therefore, most analysts feel much more comfortable banking on objectively observed fertility. Moreover, the task of estimating a structural model with cross-national data is even more difficult because the (admittedly unsatisfactory) data on DFS is available only for a small set of 37 countries which have had World Fertility Surveys. Finally, even if more satisfactory data on DFS were available for a wider sample of countries, it is difficult to find identifying exogenous variables, especially in cross-national data sets, that permit distinguishing the influences on desired family size, child survival, and ability to achieve desired family size. Female education clearly affects all three. Many analysts therefore rely on reduced form estimation of the TFR, as do we. Thus, we can determine the net impact of female secondary education and other exogenous variables but not precise pathways.

2.7 The conceptual underpinnings for the analysis of infant mortality (IMR) are more straightforward. Infant mortality is influenced by female education, male education, and access to services that affect mortality such as immunization; safe drinking water; trained birth attendants, nurses or physicians; and family planning services that promote better spacing of births. As in the case of the TFR, female education influences infant mortality through better use of available facilities and the parents', especially the mother's, knowledge of hygiene, sanitation, and health care. But as in the case of the TFR, we rely on a reduced form that shows the net impact of female secondary education and

other exogenous variables without specifying pathways.

B. Reduced Form Equations and the Estimation Procedures

2.8 Our reduced form equations derive their logic from the structural relationships outlined in the preceding paragraphs. Following Schultz (1990), the structural relationships can be expressed so that the TFR and IMR depend only on exogenous explanatory variables including education, health services, and family planning programs as well as personal and household characteristics that affect fertility and mortality. In specifying our reduced forms, we have tried to be careful to use as explanatory variables only those that are exogenous in a fairly strict sense, i.e. they affect, but are not the result of household decisions.

2.9 It is possible to estimate the determinants of fertility or mortality without bias with the OLS method when the function relating the (country-level) explanatory variables and dependent variable is correctly known, the explanatory variables are independent of each other, the variables are observed without error, and the error term is normally distributed with zero mean, has a constant variance, and is uncorrelated with the explanatory variables. But Schultz (1990) and Behrman (1990) discuss potential endogeneity between family planning or health programs and socio-economic variables, especially education levels, in countries where family planning or health program efforts may be focused on states/districts with higher levels of socio-economic development. Such endogeneity may be a less serious problem in cross-country analysis than in studies within a country. To test for endogeneity between socio-economic development and program effort at the cross-country level, we regressed an index of socio-economic development (WFS and UN 1987) on family planning services across countries, and found the correlation to be weak (R^2 = .38). Such correlations with other socio-economic and human

development indices were found to be even weaker.[1] In this paper, therefore, the possible endogeneity between program supply and socio-economic development is ignored.

2.10 Female Education and Total Fertility: The first equation presented in this study is intended to explain the total fertility rate (TFR) -- the number of children that would be born to a woman if she lives to the end of her childbearing years and bears children at each age in accordance with prevailing age-specific fertility rates. The hypothesis is that the TFR depends in a non-linear way on female and male secondary education (FED and MED) and in a linear way on per capita GDP (GDP), the rate of urbanization (URB), population per physician (PHYS), and the level of a family planning services score (SERV), and potential interaction between education and family planning services:

$$TFR = ao + a1FED + a2FED\hat{}2 + a3MED + a4MED\hat{}2 + a5GDP + a6URB + a7SERV + a8(FED*SERV) + a9PHYS + a10DAFR + a11DAS + a12DLAC + ei \quad (6)$$

where AFR, AS, and LAC stand for regional dummies for Africa, Asia and Latin America and the Caribbean.[2] The model does not separate the exact route through which education is influencing fertility (delay of marriage, contraceptive use, abortion, or breastfeeding or a reduction in child mortality), but summarizes the effects as they work themselves through an underlying structural model. The estimated equation is thus a reduced form equation with controls and interactions.[3]

---

[1] Mauldin and Ross (1991) found similar results.

[2] See the next section for definitions and exact specification of the variables.

[3] The under-five mortality rate also affects the TFR but is endogenous, since better educated women are more likely to have knowledge of preventive health care and to see medical attention for their children. Under-five mortality therefore does not enter this equation directly, but both female education and population per physician probably act in part through under-five mortality.

2.11 Female Education and Infant Mortality: Numerous studies have examined the role of female education in determining mortality outcomes using cross-country data.[4] Much of the earlier literature using cross-country data did not consider any specific health program variable, though socio-economic variables have been thoroughly investigated and modelled. King and Hill (1991) did consider many program variables but did not treat interactions. In the present study, the IMR in 1985 is hypothesized to be inversely related to lagged female and male secondary enrollments (FED and MED), the rate of urbanization (URB), per capita GDP, and family planning services (SERV), and positively to population per physician (PHYS). Regional dummies were added to capture region-specific intercepts. The estimated model is as follows:

$$IMR = ao + a1FED + a2FED\hat{}2 + a3MED + a4MED\hat{}2 + a5PHYS + a6URB + a7SERV + a8GDP + a9DUMAFR + a10DUMAS + a11DUMLAC + ei \quad (7)$$

One program variable, "population per physician" (PHYS)", was considered.[5] The model captures the influence of the proximate determinants as well as female (and male) education without informing us about the precise route through which female education influences infant mortality outcomes; so it is again a reduced form equation.

---

[4] See, for example, Preston (1980, 1985); Wheeler (1980); Mensch, Lentzner and Preston (1986), and King and Hill (1991). For thoughtful reviews of studies, see Cochrane, O'Hara and Leslie (1980, 1982), Behrman (1990) and Schultz (1992).

[5] Our measure of health services is thus obviously inadequate. We wish we had had exogenous measures of the availability of other kinds of health care. Another health variable was available, namely percent of infants immunized. But it is potentially endogenous. It reflects the interaction of demand as well as availability since better educated women are more likely to bring their children to health centers to be immunized. We therefore did not include it in our main equations but did include it in an equation shown in Appendix Table 11. It would have been most interesting had we had data on access to immunization as distinct from use, since access would have been exogenous and thus could have shown the impact of making immunization available.

2.12 To explore the routes through which female education affects fertility, data for a limited sample of countries where World Fertility Surveys were conducted were used to analyze the determinants of desired family size (DFS), and contraceptive prevalence (CP).

3. Definitions and Data Sources

3.1 The analysis is based on cross-country data for 72 developing countries compiled from various secondary sources. The sample consists of low and middle-income developing economies, according to the World Bank classification by income. We have deliberately excluded Eastern European countries for which data is scarce, Cuba and high-income countries such as Hong Kong, Saudi Arabia, Singapore and the United Arab Emirates as they are not strictly considered developing economies. The total sample of 72 countries represents the maximum number of countries for which data were available for the variables used in our analysis. Not all countries are included in all the equations and simulations owing to data gaps on certain specific variables. The approach we have taken is to maximize the number of observations in each equation; therefore the sample size varies across the equations. The countries, along with a summary of the variables and definitions, means and standard deviations, are listed in Appendix Tables 1 - 4. The total fertility rate is for 1985 (TFR) and represents the number of children that would be born to a woman if she lives to the end of her childbearing years and bears children at each age in accordance with prevailing age-specific fertility rates. The infant mortality rate (IMR), 1985, is defined as the number of infants who die before reaching one year of age per 1000 live births. Both the TFR and the IMR are taken from the World Bank's World Development Report, (WDR) 1987. Desired family size (DFS) is taken from the World Fertility Survey data from 1983 to 1988. It is based on the conventional method of measuring "preferred" family size and is available only for 37 countries from (Lightbourne, 1987). Contraceptive prevalence (CP) represents contraceptive use among currently

married women for the latest available year ranging from 1982 to 1989, as assessed in 1988 from the United Nations in Levels and Trends of Contraceptive Use and the Population Division's 1989 database on contraceptive use found in the United Nations "Women's Indicators and Statistics Spreadsheet Database for Microcomputers" (WISTAT).

3.2 Gross secondary enrollment rates for males and females for 1970 and 1975 (MED, FED) are taken from UNESCO in the World Bank's Economic and Social Database (BESD). Gross Domestic Production (GDP) per capita, 1985 is corrected for purchasing power parity and is expressed in 1985 international prices from Summers and Heston (1991). The family planning services score (SERV), 1982 is based on part of a broader index developed originally by Mauldin and Lapham (1982) and updated by Mauldin and Ross (1991). The score used in this paper assesses the availability and strength of service and service-related family planning programs in developing countries (Ross et al. 1992).[6] The index reflects 13 separate measures of service and service-related activities, including community-based distribution, administrative structure and mass media for IE & C. Service (SERV) is the percent of the maximum score for each country. The actual values range from 0 to 78. Population per physician (PHYS), 1984 and the urban population as percent of total population, (URB) 1985 are from the WDR 1987.

3.3 In the simulations, the population of women of childbearing age in 1985 is taken from WISTAT. This measure, women aged 15-44, omits women in the 45-49 bracket because the data as presently organized and published (which is for ages 15-19, 20-24, 25-44 and 45-59) does not enable us to compute the number of women in this older cohort. The number of births in this age cohort, however,

[6] This index is one of the four components which make up the family planning program effort score in 1982 of Mauldin and Ross (1991). We have chosen this component to isolate a non-endogenous supply variable.

is quite small, and as such may not significantly understate the births and deaths simulated in section 5.

4. Results and Discussion

A. Education, Family Planning Services, and Fertility

4.1 In the literature, several alternative specifications of education variables have been used. In the present study, female and male gross secondary school enrollment rates, lagged by approximately 10 and 15 years, were used, the inference being that the higher the enrollment rates in the (lagged) years, the higher the proportion of mothers (fathers) with secondary schooling in the year 1985, in each of the countries for which data on all the variables are available. Data limitations prevented looking at age cohorts separately.[7] Considering that a high proportion of births (i.e. a high proportion of the life-time, realized total fertility rate) occurs before a woman reaches the age of 25-29, 15 and 10 year-lagged school enrollment (i.e. 1970 and 1975 enrollment levels) appeared the most appropriate; the results reported belong to these years.

4.2 We estimated the equations with both female and male secondary enrollments so as to capture the effect of female enrollments, controlling for male enrollments. We recognize that male and female education tend to be correlated and therefore tried female education separately (reported in Appendix Table 5). But we felt that relying only on female education might overstate its effect. This is, we recognize, a difficult judgement. We could see no strong theoretical case for simply relying on male education. We also estimated the equations with and without interaction between female education

[7] A better approach which was not used in this paper for lack of data would be to use years of schooling completed (or estimates of same) which would take into account primary enrollment more effectively (see Schultz 1989).

and family planning services. In each equation, non-linearity in the linkages between enrollments and fertility was tested with quadratic terms. The descriptive statistics are given in Appendix Table 3, and the results are presented in Table 1.

4.3 Irrespective of the model specification, female secondary school enrollment, lagged by either 10 or 15 years, is inversely related to fertility rate, and the coefficient is relatively large and highly significant. We evaluated the positive quadratic term and found that the turning point occurs at about 60 percent of gross secondary school enrollment in 1970 and 80 percent in 1975 -- a level which none of the countries in our sample had reached in either year. Male enrollment is not statistically significant. The interaction between female education and family planning is significant: Equation 4 in Table 1 (using 1975 education data) suggests that family planning works in conjunction with education (the interaction term is significant). This implies that the effect of family planning should be evaluated with reference to specific levels of female secondary enrollment, as it differs depending on the enrollment level. It is well known that education promotes more willingness to use contraception and

Table 1. Female Education, Family Planning Services, and Total Fertility Rate

Independent Variables	Dependent Variable, TFR, 1985							
	(1) Without interaction, Sec. Sch. Enrollments 1970		(2) With interaction Sec. Sch. Enrollments 1970		(3) Without interaction Sec. Sch. Enrollments 1975		(4) With interaction Sec. Sch Enrollments 1975	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Constant	7.322	15.801***	7.199	14.385***	7.137	14.453***	6.77	12.453***
Female Secondary Gross Enrollment, 1970	-0.187	-3.723***	-0.177	-3.450***				
Female Secondary Gross Enrollment squared	0.002	2.166**	0.002	2.325**				
Male Secondary Gross Enrollment, 1970	0.038	0.996	0.029	0.709				
Male Secondary Gross Enrollment squared	0.0004	0.756	0.001	0.914				
Female Secondary Gross Enrollment, 1975					-0.116	-3.644***	-0.100	-3.079***
Female Secondary Gross Enrollment squared					0.001	1.496	0.001	1.939*
Male Secondary Gross Enrollment, 1975					0.027	1.088	0.010	0.272
Male Secondary Gross Enrollment^2					0.003	0.775	0.001	1.395
GDP per capita, 1985	-0.0001	-1.361	-0.0002	-1.490	-0.0001	-0.653	-0.0001	-0.726
Family planning services, 1982	-0.021	-3.900***	-0.014	-1.251	-0.024	-4.603**	-0.010	-0.695
Fem. Sec. Enrollment and FP services			-0.0004	-0.723			-0.001	-1.853*
Urban population as % of total population, 1985	-0.010	-1.040	-0.100	-0.871	-0.009	-0.963	-0.006	-0.613
Population per physician, 1985	-0.000004	-0.576	-0.000004	-0.497	-0.000001	-0.101	0.000001	0.07
Africa Regional Dummy	0.229	0.741	0.282	0.835	0.302	0.931	0.515	1.392
Asia Regional Dummy	-0.496	-1.249	-0.460	-1.125	-0.561	-1.361	-0.401	-0.965
LAC Regional Dummy	0.879	2.244**	0.821	2.147**	0.373	1.198	0.282	0.886
R^2	.82		.82		.83		.84	
n	64		64		65		65	

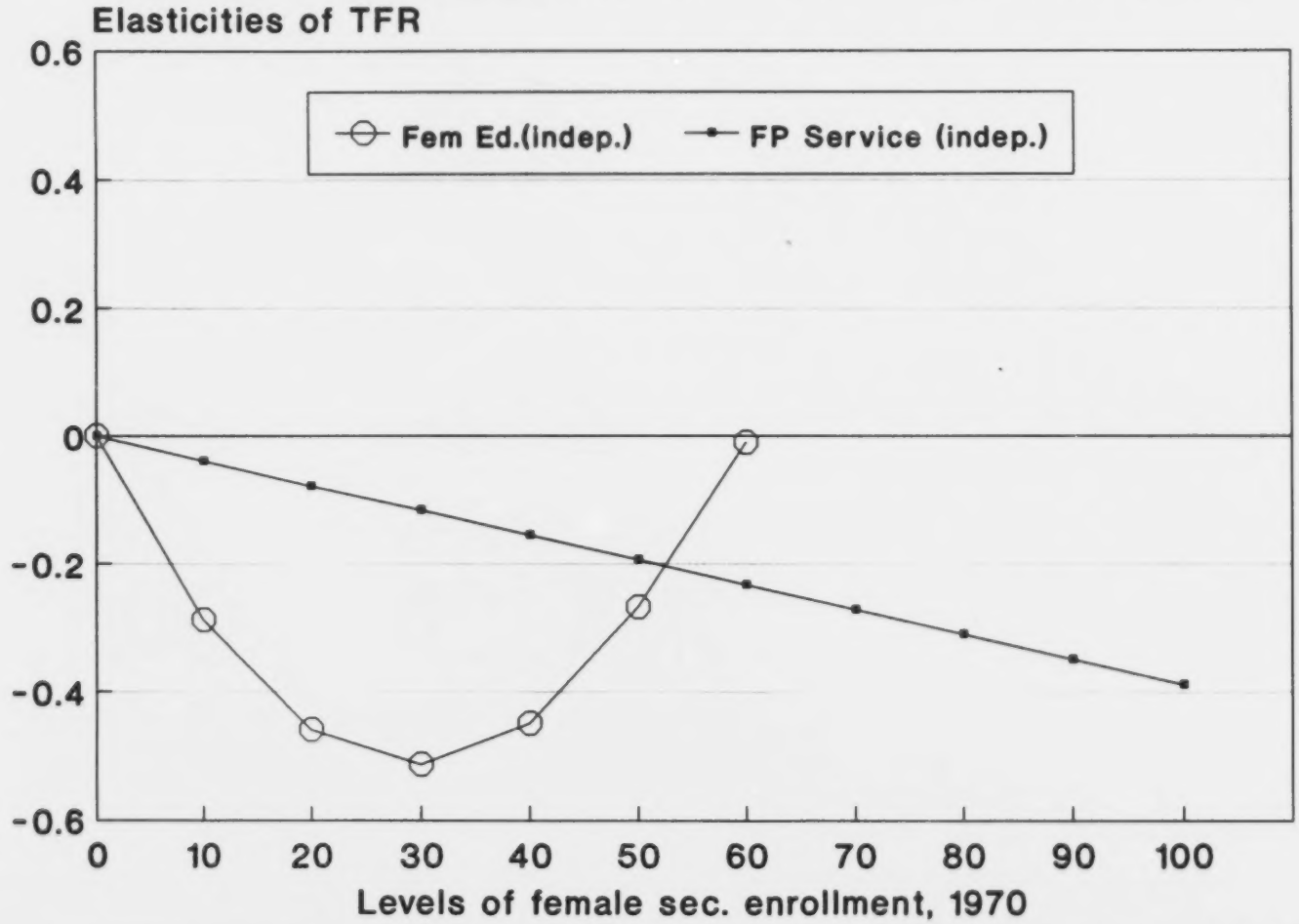
Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

more effective use. On the other hand, equation 2 in Table 1 (using 1970 education data) fails to confirm the interaction. What we can say definitely is that family planning does matter and may well interact with education, and the magnitude of the effect of female education remains large, even controlling for its interaction with family planning services. Controlling for education and family planning services, the GDP variable is significant in only one of the equations. In two equations the regional dummy for LAC is significant. On the whole, the results suggest that the total effect on fertility of female education combined with family planning services is substantial.

4.4 To get a better idea of the magnitude of the effects of female education and family planning services on total fertility, elasticities were computed. Figure 1 shows the values of elasticities of the TFR (1985) with respect to female secondary enrollments (1970) (controlling for male enrollments), and with respect to family planning services (1982) at different levels of female secondary enrollments and family planning service scores. These were computed from equation 1, Table 1. The elasticity of TFR with respect to female education has a "U" shape, suggesting that the effect of female secondary enrollment on fertility is high initially until it reaches a threshold level of and then tapers off. The elasticity of fertility with respect to female education is very high for female enrollments from 0 to 40 percent -- a range in which all but 4 of the sample countries fall. Female secondary enrollment has the greatest negative effect on fertility at around 30 percent enrollment; the mean of female secondary enrollment in the 1970 sample is 13 percent. Family planning services undoubtedly reduce the fertility rate,[8] but the magnitudes of the elasticities of the TFR with respect to family planning services are small.

[8] In this equation, since it does not have an interaction term, we can estimate the independent effect of family planning services.

Figure 1: Elasticities of TFR 1985, with respect to Female Secondary Enrollments, 1970 and FP Services, 1982



Note: Elasticities computed from eq.1 Table 1, holding all other variables constant at their mean value. (Means: Female Sec. Enroll. (1970), 13%, Family Planning Service Score (1982), 24%, TFR (1985), 5.4).

Only at the maximum possible score of the index (100) does the elasticity of fertility with respect to family planning services reach that of female education at 30 percent enrollment rate.[9] Yet the highest score of family planning service any country in 1982 was 78.

4.5 We use the equation with female secondary enrollments for 1975 in subsequent simulations of the effects of increasing female education and family planning services on TFR[10]. When female secondary enrollments lagged by 10 years (1975 enrollments) were interacted with family planning services, the interaction term is significant (see equation 4, Table 1). From this equation, the elasticities of the TFR with respect to the total effect of female secondary education family planning services were computed at different levels of enrollments and service scores. These are shown in Figure 2. At 20 percent enrollment level, the elasticity of the TFR with respect to the total effect of female education is three times higher than that of family planning services. Clearly, in countries with currently low female secondary enrollments, an expansion of female education, in combination with even a low family planning service score, can bring fertility down substantially.

4.6 Simulations show that a doubling of female secondary enrollments (from the mean of 19 percent to 38 percent) in 1975 holding all other variables constant at their mean values, would have reduced the TFR in 1985 from 5.3 to 3.9, whereas a doubling of family planning service score[11] (from the mean of 25 percent to 50 percent), again holding other variables constant, would have reduced the TFR in 1985 from 5.5 to 5.0. These illustrative scenarios are suggestive of the powerful influence of

---

[9] See Appendix Table 6 for actual values of the elasticities.

[10] We found the 1970 equation to yield unrealistic declines in TFR as a resut of increasing female secondary enrollments by one percent, e.g. a reduction of close to 0.2 or a fifth of a child, in comparison to a tenth of a child in the 1975 equation.

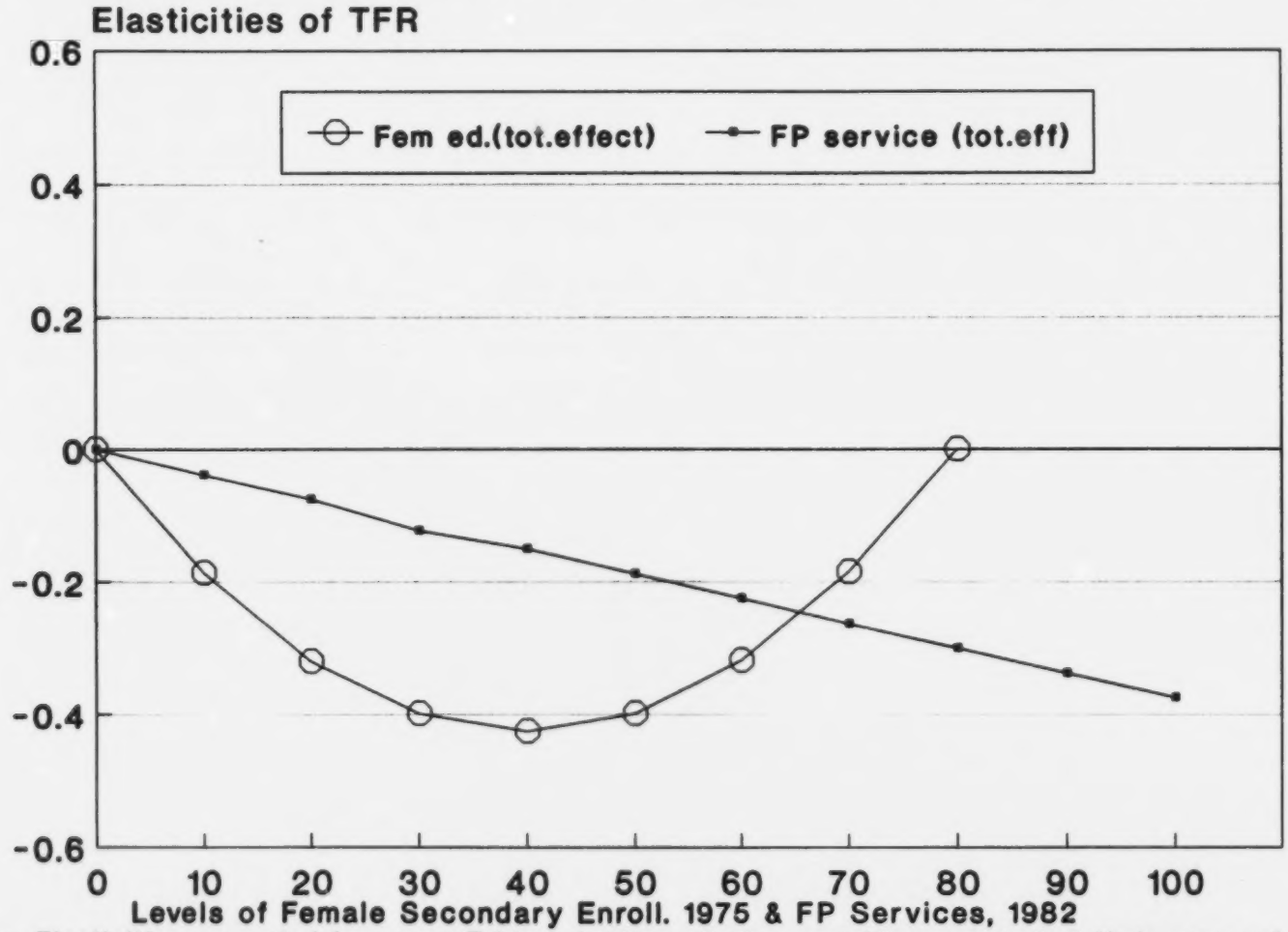
[11] The independent effect of family planning services cannot be estimated from this equation as the variable is non-significant. The effect of family planning services can only be evaluated with reference to specific levels of female enrollment.

female education in fertility reduction and the potential from combinations of female education and effective family planning programs.

4.7 The extent to which female education, interacting with the mean level of family planning services, reduces fertility can also be seen from the predicted values of total fertility rate, also derived from equation 4, Table 1. Figure 3 presents the predicted values of total fertility rate in 1985 for varying levels of female enrollments in 1975 and family planning services in 1982. The fertility rate falls steadily with increases in female secondary enrollments. The rate of decline in fertility appears steep initially, but tapers off after female enrollment levels reach 40 percent. Family planning services also reduce fertility but by a slower rate. Even with the maximum family planning service score of 100 (quadruple the mean of 25 percent in 1982), fertility does not reach the same level as with 40 percent female secondary enrollment. It would appear that expansion of family planning services by itself affects fertility much less than if it were accompanied by expansion of female secondary enrollment,[12] and the maximum effect on fertility can be achieved with a combination of female education and family planning. This should not be surprising since family planning enables couples more easily to achieve their family-size preferences, which reflect their education levels inter alia.

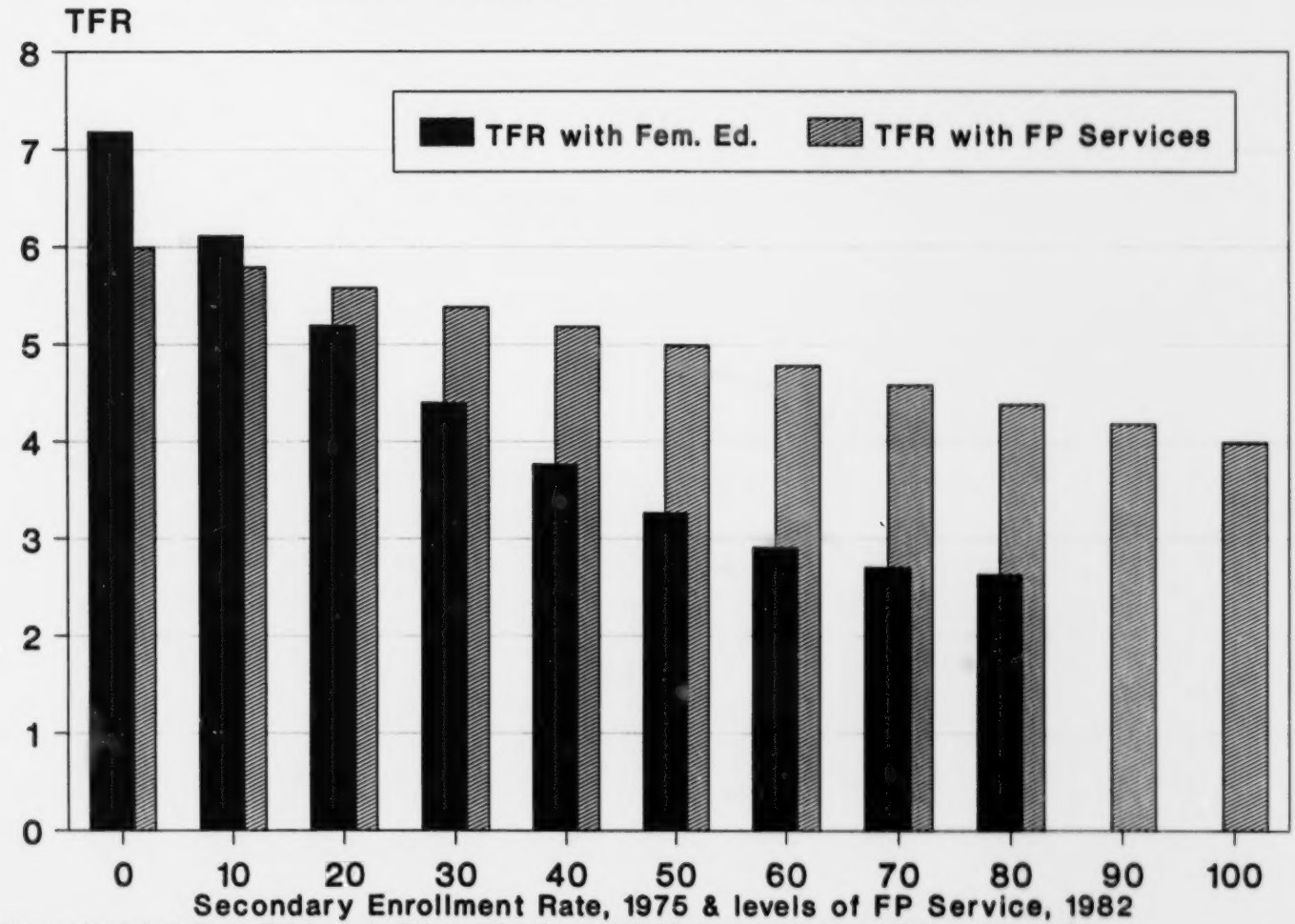
[12] Several micro-level studies based in household data sets have reached similar conclusions. For example, one recent careful study based on Indonesian household-level data set confirms the small contribution of family planning program efforts to fertility decline (P. Gertler and J. Molineaux, 1992). In this study, the authors show that over the period 1982-87, the combined educational and economic impacts, working through increases in contraceptive use, accounted for 87 per cent of fertility decline over the period. By contrast, measures of family planning program inputs were responsible for only 4 to 8 per cent of the decline. Of course, this study uses a fixed effects model which relates changes during 1982-86 in family planning inputs and socio-economic variables to changes in contraceptive use and fertility. Since family planning was already quite well established in 1982, these results may reflect this context.

Figure 2: Elasticities of TFR with respect to Female Secondary Education, 1975 and FP Services, 1982



Note: Elasticities computed from eq.4 Table 1, holding all other variables constant at their mean value. (Means: Female Sec. Enroll. (1975), 19% Family Planning Service Score (1982), 25% TFR 5.3)

Figure 3: Predicted TFR, 1985 for Different Levels of Female Education & FP Services



Note: calculated from Table 1, holding all other variables constant at their mean value.
(Means: Female Sec. Enroll. (1975), 19.1%, Family Planning Service Score (1982), 25%, TFR (1985) 5.3).

B. Female Education, Desired Family Size and Contraceptive Prevalence

4.8 Female education affects fertility in several ways, but we consider two ways: it reduces the desired family size, and it promotes contraceptive use. There are important empirical problems in mapping out these effects. For example, desired fertility could fall for a variety of reasons of which female education is one. Similarly, contraceptive prevalence could increase due to many factors. There are (unknown) time lags in each effect. There are, of course, serious data and measurement problems, as discussed in para 2.6 above. For example, desired family size is available from WFS surveys only for 37 countries, may not be exactly comparable across countries, and reflects subjective judgments. These limitations must be taken into consideration when interpreting the results.

4.9 Data from World Fertility Surveys shown in Figure 4 depict the total (actual) fertility and desired fertility for a sample of 37 countries in 1988, along with the country's female secondary enrollment rate in 1975. Above a female secondary enrollment of about 40 percent, actual and desired fertility rates begin to converge, indicating that women with more education are better able to reach their desired fertility. In Figure 5 contraceptive prevalence, total fertility and female secondary school enrollments are plotted. As expected, contraceptive prevalence increases and total fertility decreases with higher levels of female education.

4.10 The results on DFS and CP were obtained from two regressions with desired family size (DFS) and with contraceptive prevalence (CP) as the dependent variables; the estimated equations are presented in Tables 2 and 3 and show the role of female secondary education relative to other factors.

Figure 4: Total and Desired Fertility

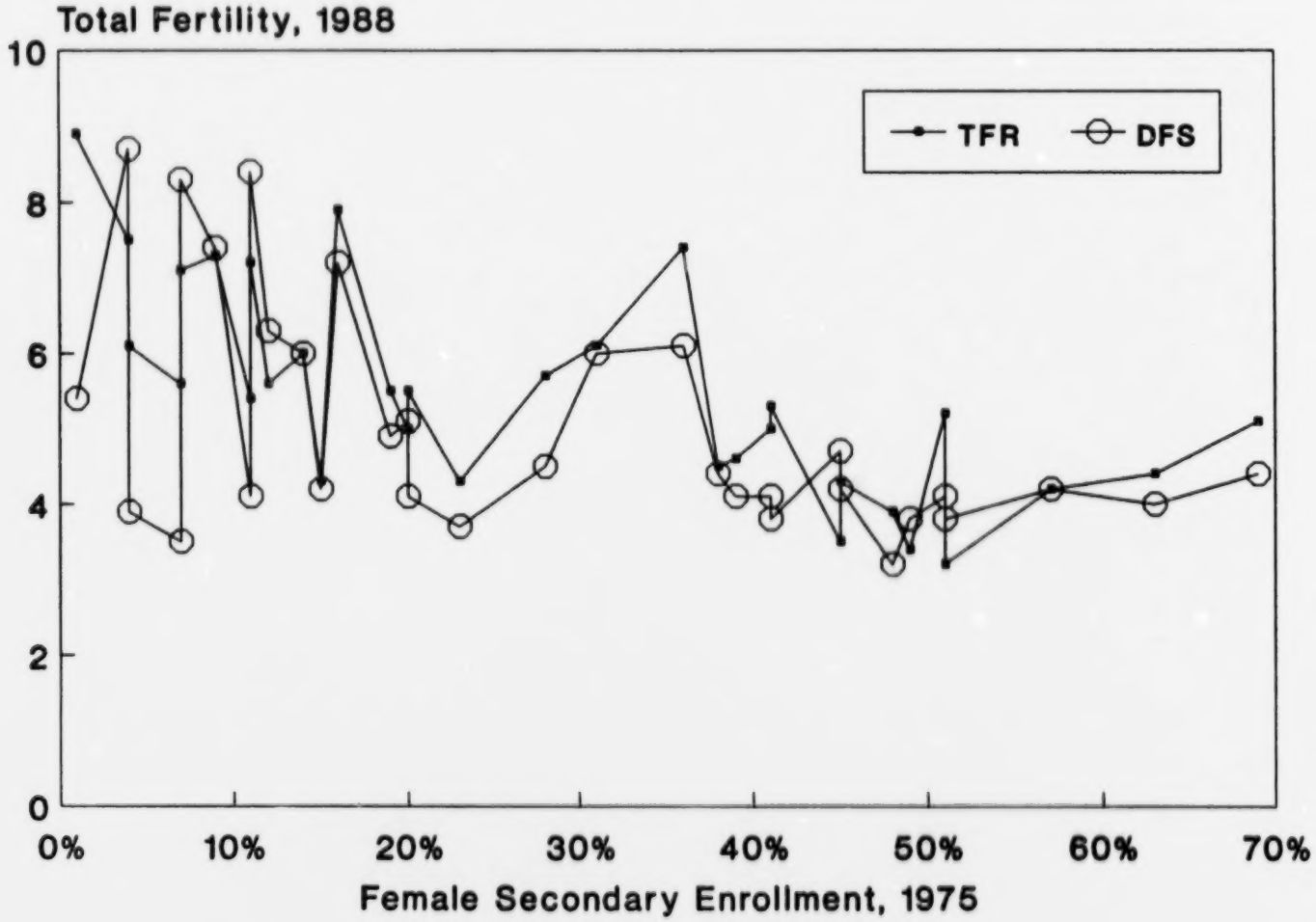
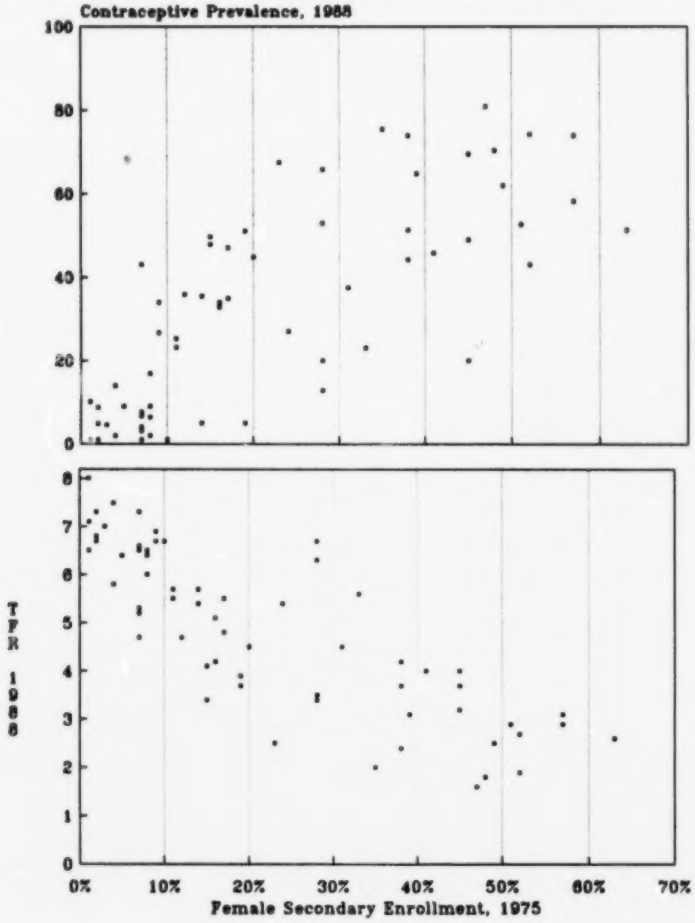


Figure 5: Female Secondary Enrollment, Contraceptive Prevalence and TFR, 1988



The independent variables include male and female secondary enrollments, GDP per capita, and regional dummies, and family planning services in the CP equation. The equations were also estimated allowing female secondary enrollments to enter separately. In both DFS and CP equations, the coefficient of female secondary school enrollments is highly significant with the expected signs for the linear term and the quadratic term; the turning point occurs only at a high (40 percent) level of female secondary enrollment.[13] While the male education variable is not significant, GDP per capita is highly significant in both DFS and CP equations. Ceteris paribus, a rise in GDP per capita leads to a higher desired family size up to a threshold level reflecting the positive income effect on fertility, but beyond a threshold level increases in GDP lead to a fall in desired family size; the quadratic terms for GDP are highly significant with a negative sign. The impact of an increase of GDP per capita on contraceptive prevalence (CP) is also non-linear; it leads to a rise in CP initially, but after a threshold income level, it has a negative impact on CP. Family planning services are highly significant and has positive impact on CP.

4.11 The elasticities of contraceptive prevalence with respect to secondary school enrollment, GDP per capita, and access to family planning services are shown in Figure 6. The elasticity with respect to education has an inverted "U" shape, peaking again at 30 percent enrollment with an elasticity of 0.33. However, it is worth stressing that the family planning service score is an extremely important determinant of contraceptive prevalence. The service component has a strong positive upward slope, and at a score level of 20, reaches the same contraceptive prevalence level as for 10 percent female enrollment.[14]

---

[13] When female secondary enrollments were entered without male enrollments (see Appendix Table 7) female secondary enrollments still retain their high statistical significance.

[14] The actual values of these elasticities are given in Appendix Table 8.

Table 2. Female Education, GDP per capita and Desired Family Size

Independent Variables	Dependent Variable, DFS, 1988	
Constant	3.404	3.817***
Female Secondary Gross Enrollment, 1975	-0.109	-2.781***
Female Secondary Gross Enrollment^2	0.001	2.579***
Male Secondary Gross Enrollment, 1975	0.018	0.320
Male Secondary Gross Enrollment^2	0.00001	0.125
GDP per capita, 1988	0.001	2.381**
GDP per capita^2	-0.0000001	-2.162**
Africa Regional Dummy	3.181	7.301***
Asia Regional Dummy	-0.147	-0.361
LAC Regional Dummy	0.392	0.865
Adjusted R^2	.74	
n=	32	

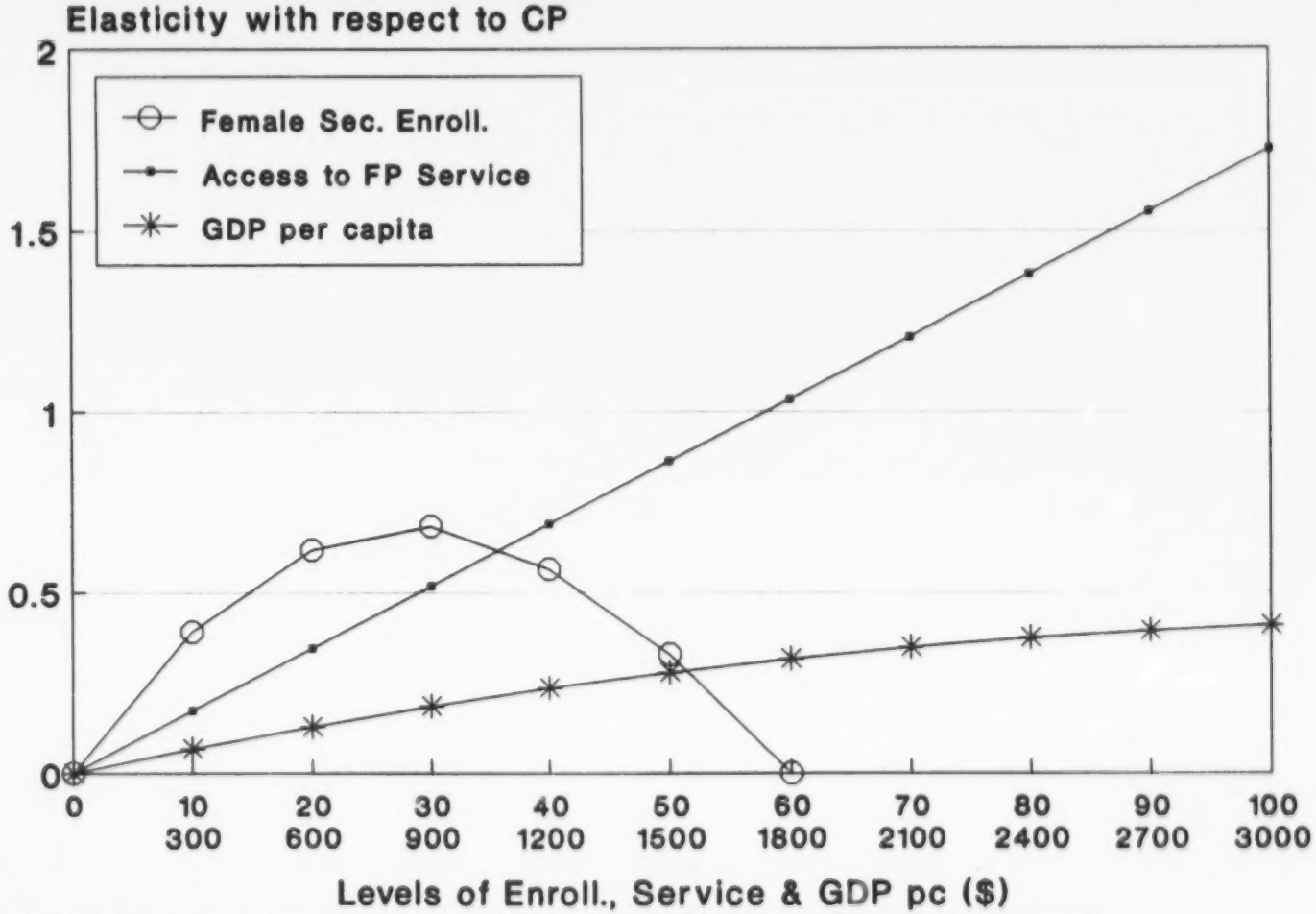
Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

Table 3. Female Education, GDP per capita and Contraceptive Prevalence

Independent Variables	Dependent Variable, CP, 1988	
	Coefficient	t-ratio
Constant	-8.166	-1.572
Female Secondary Gross Enrollment, 1975	1.437	2.683***
Female Secondary Gross Enrollment^2	-0.012	-1.924*
Male Secondary Gross Enrollment, 1975	-0.040	-0.093
Male Secondary Gross Enrollment^2	-0.005	-0.970
GDP per capita 1988	-0.007	-3.107***
GDP per capita^2	-0.000001	-2.655***
Family planning services 1982	0.526	7.701***
Africa Regional Dummy	-0.525	-0.150
Asia Regional Dummy	-5.351	-1.451
LAC Regional Dummy	-3.738	-0.817
R^2	.83	
n	61	

Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

Figure 6: Elasticities of Contraceptive Prevalence with respect to Female Enrollments, 1975, FP Services & GDP pc



Note: Elasticities computed from eq. 1 Table 3, holding all other variables constant at their mean values.

(Means: Fem. Sec. Enroll., (1975) 20.4%, Access to Services (1982) 28%, GDP per capita (1988) $2324, CP 30.6)

4.12 Controlling for female education, the elasticity of CP with respect to GDP per capita is smaller. It could be argued that progress in contraceptive prevalence may occur quickly (without timelags) as GDP per capita grows, whereas the female education route would require more "waiting". But this argument may be more hypothetical than real. Consider a typical, poor country with per capita GDP under $ 300 and a female secondary enrollment rate of 10 percent. If this country wants to promote contraceptive prevalence by 1 percent in 1985, it would involve an increment of female secondary school enrollment of 2.4 percent in 1975 and a wait of 10 years. That country might in theory raise GDP per capita and achieve the same objective more quickly, say in one year, without any time lag. However, to do this, the country would need annual GDP per capita growth of 14 percent, which is not usually feasible. A per capita GDP growth of this magnitude was achieved by few countries during the entire decade of the 1980s, especially in Sub Saharan Africa.[15] Thus, while "waiting time" may seem a disadvantage in the female education route to fertility reduction, the income route may also not be quick. Building a sound institutional and administrative framework for effective family planning programs also needs time.

C. Female Education, Access to Medical Care, and Child Health

4.13 The results relating to the determinants of infant mortality are presented in Table 4. One public program variable is considered: population per physician. Of course, this measure of health programs affecting the IMR is highly inadequate (as we acknowledge in footnote 6). We considered using additional variables, namely access to safe drinking water and the percentage of infants immunized, but were unable to use the former due to lack of reliable data, and the later due to its endogeneity and

[15] See World Bank (1989), Sustainable Growth with Equity: Sub-Saharan Africa.

the lack of a good instrumenting variable to measure access rather than use.

4.14 Female secondary enrollments again are highly significant. The quadratic terms are positive but not statistically significant. Male education is not statistically significant for either 1970 or 1975 enrollments[16]. The health program effort variable, population per physician, is highly statistically significant in all equations. GDP per capita is also significant with the expected negative sign. Family planning services is negative and statistically significant only in the equation with 1975 enrollments, while the urban variable is positive and significant in the 1970 equation only. The LAC regional dummy is significant in the 1975 equation. Thus, even after controlling for income and the program variable, female secondary education is clearly a prime factor in reducing the IMR.

4.15 The elasticities of the IMR with respect to female enrollments in 1975, population per physician and GDP per capita have been computed from Table 4 and are shown in Figures 7a and 7b. The direction of the results was similar for the 1970 equations, thus only the results with 1975 enrollments are presented here. The elasticity of IMR with respect to female secondary enrollment sharply rises to -0.92 at an enrollment level of 40 percent; whereas the elasticity of IMR with respect to GDP per capita is low at -0.21 even at a per capita GDP level of $1800.[17] The elasticity of IMR with respect to population per physician is positive and decreases as the ratio decreases. It reaches 0.06 percent when the ratio of population per physician is halved (from the mean). For a typical, poor country with a GDP per capita of $300, a female secondary enrollment rate of 10 percent, and physician for every 15,000 people, let us consider alternative approaches to reducing infant deaths. A doubling of female enrollments (from 10 percent to 20 percent) would bring down the IMR from 105 to 78, whereas a doubling of GDP per capita would reduce IMR from 102 to 99. Halving the ratio of population per

[16] Appendix Table 10 presents the results when female education alone is entered into the equation.

[17] The actual values of these elasticities are given in Appendix Table 9.

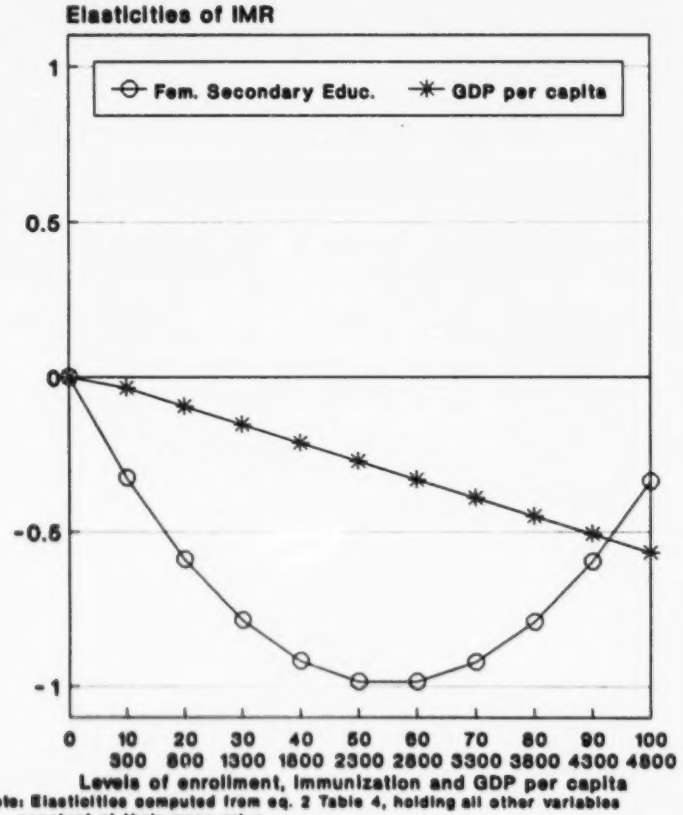
physician would reduce the IMR from 85 to 81. These illustrative scenarios suggest the powerful influence of mother's education in the prevention of infant deaths.

Table 4. Infant Mortality (1985), Female Education and Program Variables

Independent Variables	Dependent Variable, IMR 1985			
	(1) Enrollments 1970		(2) Enrollments 1975	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	85.246	7.474***	98.849	7.561***
Female Secondary Gross Enrollment Rate, 1970	-3.309	-2.373**		
Female Secondary Gross Enrollment Rate squared	0.020	0.946		
Male Secondary Gross Enrollment Rate, 1970	1.609	1.718		
Male Secondary Gross Enrollment Rate squared	-0.01	-0.494		
Female Secondary Gross Enrollment Rate, 1975			-3.055	-3.720***
Female Secondary Gross Enrollment Rate squared			0.014	1.237
Male Secondary Gross Enrollment Rate, 1975			0.710	1.113
Male Secondary Gross Enrollment Rate squared			0.01	0.910
Family planning services	1.049	1.047	-0.187	-1.682*
Population per physician, 1984	0.001	2.433**	0.001	3.795***
Urban population as % of total population	0.660	1.681*	0.389	1.571
GDP per capita, 1985	-0.018	-2.466**	-0.010	-3.872***
Africa Regional Dummy	8.540	0.604	10.470	1.532
Asia Regional Dummy	3.252	0.229	9.299	1.118
LAC Regional Dummy	20.611	1.080	19.094	2.315**
Adjusted R^2	.75		.73	
n=	64		65	

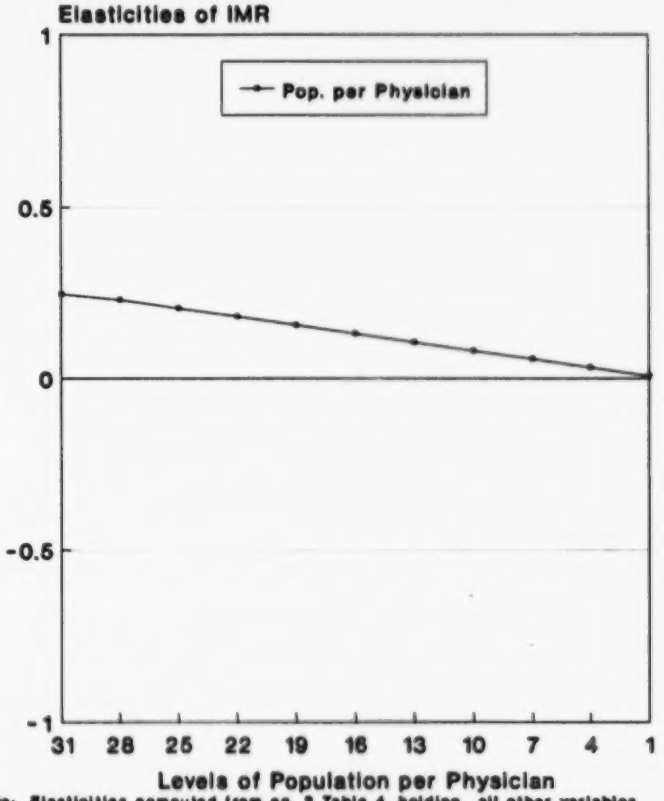
Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

Figure 7a: Elasticities of IMR, 1985 with respect to Female Secondary Enrollment, 1975 & GDP, 1985



Note: Elasticities computed from eq. 2 Table 4, holding all other variables constant at their mean value.
(Means: Fem.Sec.Enroll.(1975) 19% GDP per capita (1985) $1976,IMR (1985),88.

Figure 7b: Elasticities of IMR, 1985 with respect to Population per Physician, 1984 (000's)



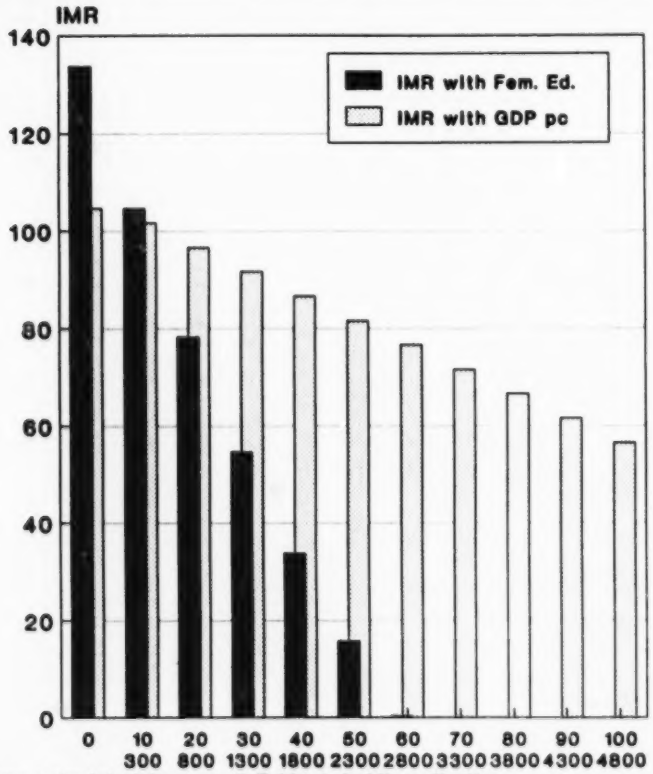
Note: Elasticities computed from eq. 2 Table 4, holding all other variables constant at their mean value.
(Means: Population per Physician (1984), 11851, IMR (1985) 88.

4.16 To examine the above scenarios more clearly, the response of the IMR to female education relative to population per physician and GDP per capita is shown in Figures 8a and 8b, which give the predicted values of the IMR for different levels of female secondary enrollments, holding all other variables constant at their mean level. The IMR falls steadily until female secondary enrollment reaches 50 percent. Also as expected, a rise in GDP per capita leads to a fall in IMR, ceteris paribus, with a slightly steeper slope than for population per physician. However, a GDP level of $4800 -- a clearly implausible proposition for many developing countries even within a decade -- would be needed to reach the level of IMR obtained with 30 percent female secondary enrollments. The IMR falls after halving the ratio of population per physician (again keeping all other variables, including female secondary enrollments constant at their mean level), but at a much lower pace compared to female enrollments. Thus, for developing countries, female education appears to be a powerful way to reduce infant deaths.

4.17 The combined effect of fertility reduction and improvement in infant survival from increasing female enrollments can be seen from the predicted values of each plotted in Figure 9.[18] The reduction in fertility and improvement in infant survival are striking. The simulation shows that with increasing levels of female secondary enrollment in 1985, not only does the number of births per woman fall, but the proportion of infants who survive rises. Doubling the mean level of female education from 19 percent to 38 percent, holding all other variables constant at their mean values, would reduce the TFR from 5.3 to 3.9. Similarly, the proportion of infants surviving increases as the IMR falls from 81 to 38.

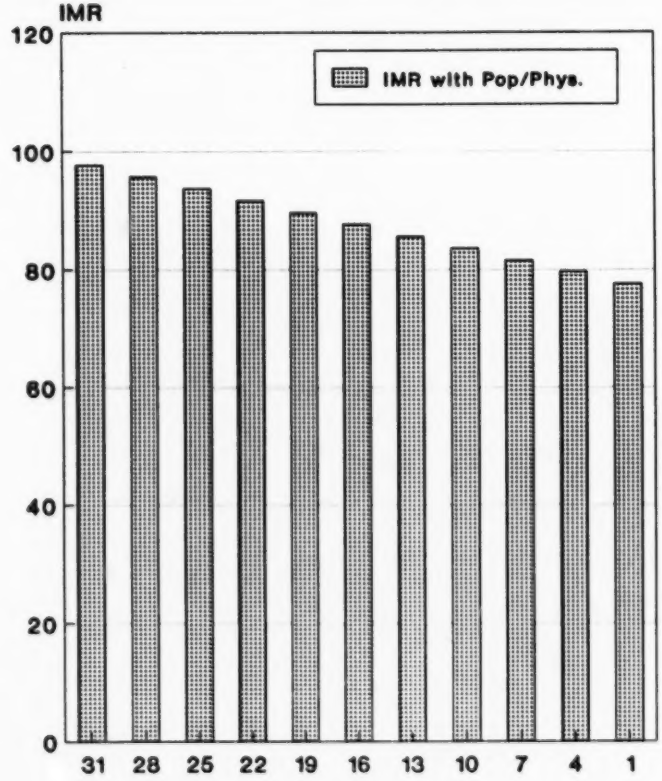
[18] Infant survival rate computed as 1-(IMR/1000) multiplied by TFR.

Figure 8a: Predicted IMR, 1985 for different levels of Female Secondary Enrollment, 1975, & GDP pc, 1985



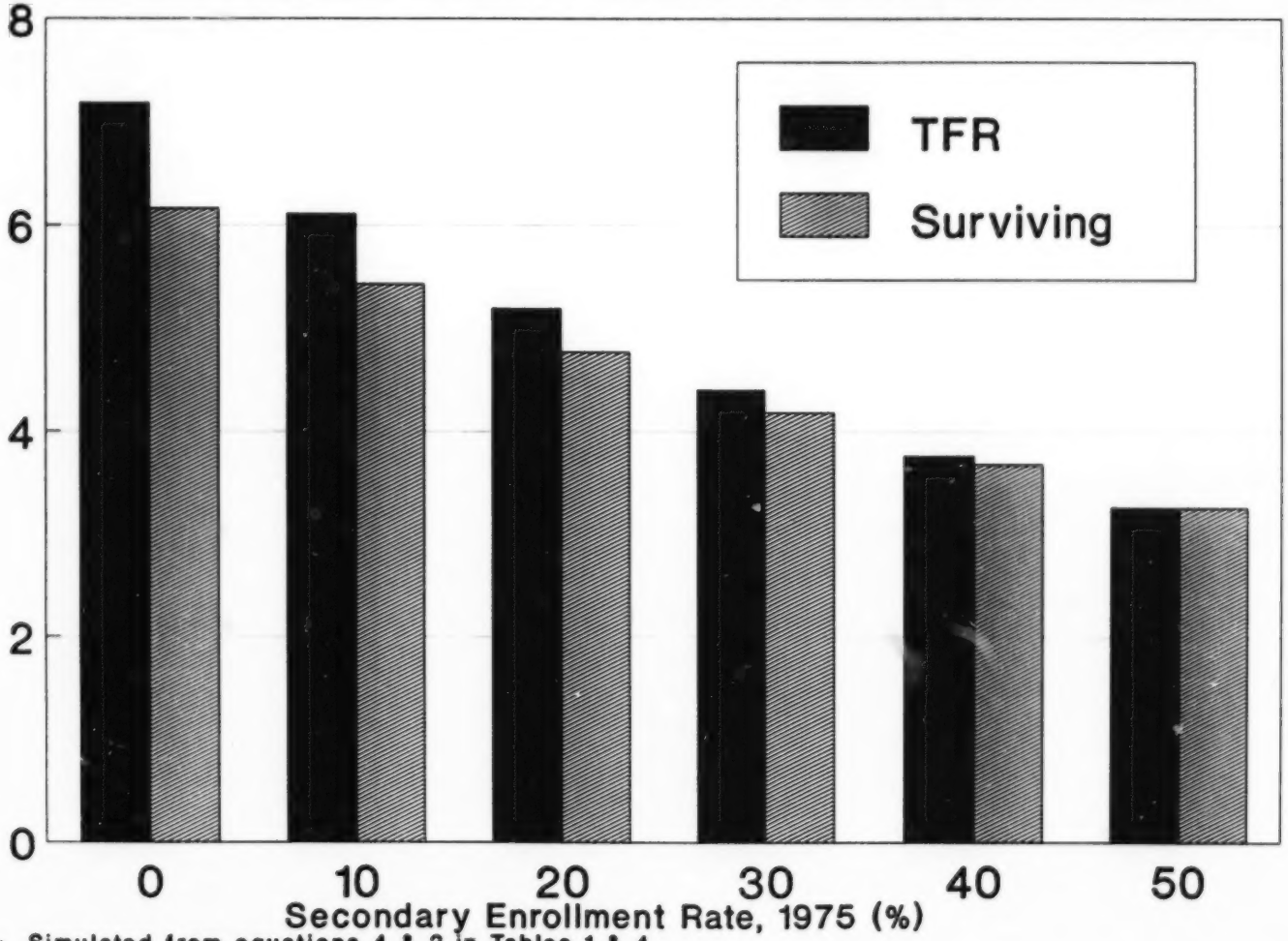
Note: calculated from eq. 2 Table 4, holding all other variables constant at their mean value.
Means: Female Secondary Enrollment (1975), 19%, GDP pc capita (1985), $1976.

Figure 8b: Predicted IMR, 1985 for different levels of Population per Physician, 1984 (000's)



Note: calculated from eq. 2 Table 4, holding all other
Means: Population per physician (1984), 11851, IMR (1985)

Figure 9: Predicted TFR and Infant Survival Rates at different levels of Female Secondary Enrollment in 1975



Note: Simulated from equations 4 & 2 in Tables 1 & 4
(holding all other variables constant at their mean value.)

5. Quantifying the Gains in Fertility and Mortality Reduction: Some Simulations

5.1 The econometric estimates obtained from cross-country analysis can be used to simulate what the impact in the 1980s would have been had the female secondary school enrollment rate been double its actual its average in 1975, keeping all other variables (including health and family planning services) constant at their mean values. The impact of doubling (and trebling) the family planning services index was also simulated. In both simulations, the results take into account the synergism between female education and family planning services. The results (shown in Table 5) are striking. For a sample of 65 low and middle income developing countries (including China) which account for 93 percent of the population of developing countries, doubling female secondary enrollment from the mean of 19 percent to 38 percent in 1975, in combination with family planning services (held constant, along with all other variables, at their mean values), would have reduced the number of births by 29 percent compared to the actual in 1985[19]. Doubling the family planning services score, interacting with an unchanged female enrollments (held constant at its mean value along with all other variables), would have reduced the number of births by 3.5 percent. Of the developing countries, only two have been able to reach a service level of 75 (China and Indonesia have scores of 78), whereas as many as 14 developing countries, some of which with relatively low per capita GDP such as Sri Lanka and Indonesia, reached 40 percent female secondary enrollment level in 1975, and this number rose to 28 in 1988. The highest gains (in terms of births averted as percent of actual) from female education occur in the countries of South Asia and Sub Saharan Africa.

---

[19] Calculated using the predicted values of TFR and actual female population of childbearing age (15-44) in the sample countries for 1985.

Table 5. Gains in Births Averted through Female Education and Family Planning Program Services: Simulation Results[1/]
Births per year, 1985 (millions)

	Raising Female Secondary Enrollments					Raising Family Planning Services			
Countries[2/]	Actual	Remarks	Simulated	Births Averted	Col. 5 as % of col. 2	Remarks	Simulated	Births Averted	Col. 9 as % of col. 2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Low and Middle Income (n=65)[3/]	102.5	Scenario 1: if female gross enrollment rates in 1975 were doubled to 38% from 19% (actual).[4/]	72.9	29.6	29	Scenario 1[a/]	98.9	3.6	3.5
						Scenario 2[b/]	93.4	9.1	8.9
Low Income (n=31)[5/]	81.2		55.6	25.6	32	Scenario 1[a/]	79.6	1.6	2.0
						Scenario 2[b/]	77.1	4.1	5.0
Sub-Saharan Africa (n=26)[6/]	17.4		11.3	6.1	35	Scenario 1[a/]	16.2	1.2	6.9
						Scenario 2[b/]	15.5	1.9	11.0
South Asia (n=5)[7/]	33.9		17.7	16.2	48	Scenario 1[a/]	33.7	0.2	0.6
						Scenario 2[b/]	31.9	2.0	5.9

1/ These simulations are based on equation 4 in Table 1.
2/ According to World Bank classification.
3/ These 65 countries represent 76% of the world's population and 93 of the LDC population, including China.
4/ Keeping all other variables constant at their mean values.
5/ These 31 countries represent 61% of the world's population and 97% of the low-income LDC population, including China.
6/ These 26 countries are: Benin, Botswana, Burkina Faso, Burundi, Central African Republic, Cote d'Ivoire, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Sierra Leone, Somalia, Sudan, Tanzania, Togo, Uganda, Zaire, Zambia, and Zimbabwe. They represent 8.7% of the world's population and 94% of SSA's population.
7/ These 5 countries are: Bangladesh, Nepal, India, Pakistan, and Sri Lanka. They represent 23.1% of the world's population and 96% of South Asia's population.

a/ Scenario 1: if family planning service index score in 1982 were doubled to 50%, from 25% (actual) (see footnote 4).
b/ Scenario 2: if family planning service index score in 1982 were tripled to 75%, from 25% (actual) (see footnote 4).

5.2 Table 6 shows similar simulations for gains in the reduction of infant deaths. Doubling female secondary school enrollments has a dramatic impact on infant deaths averted, reducing them by 64 percent for the sample of developing countries as a whole. The gains in terms of deaths averted are again highest in South Asia and Sub Saharan Africa. Reduction of the ratio of population per physician results in prevention of infant deaths, but to a much smaller extent (2.5 percent), while an increase in GDP per capita from $650 to the median level in the sample of $1300 has no effect on infant deaths.

5.3 The simulations show the virtue of expanding education as well as health and family planning services to reduce fertility and promote child health. Just expanding female education itself would have a significant impact. However, combining female education with health and family planning services would have the greatest impact on the reduction of births and infant deaths. At the same time, the simulations suggest that exclusive reliance on health and family planning program efforts, without expanding female education, will not affect the TFR and IMR substantially, especially in very poor countries with a low female secondary education base. Female education is thus a powerful force for health and family planning in the developing world.

Table 6. Gains in Infant Deaths Averted through Female Education versus Health Services and GDP per capita change: Simulation Results[1/]
Infant Deaths per year, 1985 (millions)

Countries[2/] (1)	Actual (2)	Remarks (3)	Simulated (4)	Averted (5)	Col. 5 as % of Col. 2 (6)	Remarks (7)	Simulated (8)	Averted (9)	Col. 9 as % of Col. 2 (10)	Remarks (11)	Simulated (12)	Averted (13)	Col. 3 as % of Col. 2 (14)
Low & middle income (n=65)[3/]	8.0	The scenario if female gross enrollment in 1975 were doubled from 19% (actual) to 38%.[4/]	2.9	5.1	64	Scenario halving the ratio of population per physician in 1984 from 11,851 (mean) to 5926.[4/]	7.8	0.2	2.5	Scenario raising GDP per capita level from $650 in 1985 to the median of $1300.[4/]	8.0	0	0
Low income (n=31)[5/]	6.8		2.3	4.5	66		6.6	0.2	2.9		6.8	0	0
Sub-Saharan Africa (n=26)[6/]	2.1		0.4	1.7	81		1.9	0.2	9.5		2.0	0.1	4.8
South Asia (n=5)[7/]	3.2		0.7	2.5	78		3.2	0	0		3.2	0	0

1/ These simulations are based on equation 2 in Table 4.
2/ According to World Bank classification.
3/ These 65 countries represent 76% of the world's population and 93 of the LDC population, including China.
4/ Keeping all other variables constant at their mean values.
5/ These 31 countries represent 61% of the world's population and 97% of the low-income LDC population, including China.
6/ These 26 countries are: Benin, Botswana, Burkina Faso, Burundi, Central African Republic, Cote d'Ivoire, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Sierra Leone, Somalia, Sudan, Tanzania, Togo, Uganda, Zaire, Zambia, and Zimbabwe. They represent 8.7% of the world's population and 94% of SSA's population.
7/ These 5 countries are: Bangladesh, Nepal, India, Pakistan, and Sri Lanka. They represent 23.1% of the world's population and 96.3% of South Asia's population.

6. Implications for Policy and Concluding Remarks

6.1 This paper explored the strength of female secondary enrollment relative to, and/or in combination with some health and family planning program efforts to reduce fertility and infant mortality in the developing world. The relative strength of these strategies seems to vary at different levels of socio-economic development, suggesting the need for careful consideration of priorities especially in countries with low female secondary enrollments. The equation with 1975 enrollment rates suggests that effect of family planning services should be evaluated with reference to specific levels of female enrollments. The elasticity of the total fertility rate with respect to female secondary enrollments is consistently higher than for family planning services, ceteris paribus. Thus expansion in female education reduces fertility substantially and even more when family planning services accompany it. For example, a doubling of female secondary enrollments in 1975 from the mean of 19 percent to 38 percent would have reduced the fertility rate from 5.3 to 3.9, whereas a doubling of family planning services in 1982 from the mean of 25 to 50 would have reduced the total fertility rate from 5.5 to 5.0. In countries where the female secondary education base is low, this research suggests that the expansion of female secondary education may be the best single policy lever for achieving substantial reductions in fertility. However, couples who desire smaller families certainly ought to have good family planning options at hand, and improvements in family planning will enable and encourage more couples to opt for contraception.

6.2 With respect to infant mortality, public programs with reduction in the ratio of population per physician coverage do reduce infant deaths independently of female education. However, the elasticities of the IMR with respect to female secondary enrollments are always greater than with reduction in the ratio of population per physician coverage or GDP per capita. Our simulations show that the reduction in IMR from expansion of female enrollments is striking. For example, in a typical poor country with a GDP per capita of $300, female secondary enrollment of 10 percent, and a physician for

every 12,000 people, a doubling of female education in 1975 would have reduced the IMR in 1985 from 105 to 78; in comparison, a halving of the ratio of population per physician would have lowered the IMR from 85 to 81, and a doubling of GDP per capita would have lowered the IMR from 102 to 99. When the results are translated into deaths averted, the magnitude of reductions in deaths obtained from small increments in female education swamp the reduction in IMR obtained from even massive direct programs; for example, while doubling female enrollment rate reduces infant deaths by 64 percent, halving the ratio of population per physician reduces infant deaths by 2.5 percent. Of course, our measure of health programs is very imperfect and doubtless understates the impact of health care. But it is reasonably clear that expanding female education is a powerful option for many developing countries.

6.3 The simulations attempted in this paper show that the gains from female education in terms of births averted are also striking. For example, doubling female secondary school enrollments from their mean level in 1975, keeping all other variables (including family planning services) constant at their mean values, would have lowered births by 29 percent compared to the actual number in 1985. Doubling the family planning service score, keeping all other variables constant at their mean values, would have reduced births by 3.5 percent. The gains from expansion of female secondary schooling are largest in South Asia and Sub-Saharan Africa where the female enrollment rates were among the lowest in the world in 1975. Since then there has been progress; yet even as of 1989, 25 out of 27 countries with female enrollment rates of less than 20 percent are in Sub Saharan Africa and South Asia.

6.4 The broad conclusion of this study is that family planning and health programs reduce fertility and mortality, and the impact of expanding female secondary enrollments appears to be even greater, especially in countries with low female secondary enrollment. The gains are, of course, greatest when female education is combined with health and family planning programs.

References

Behrman, J.R. 1990. "The Action of Human Resources and Poverty on One Another: What We Have Yet to Learn," LSMS Working Paper, No. 74. Washington, D.C.: World Bank.

Cochrane, S. 1988. "The Effects of Education, Health, and Social Security on Fertility in Developing Countries, World Bank Staff Working Paper No. 93. Washington, D.C.: World Bank.

Cochrane, S. and D.K. Guilkey. 1992. "Fertility Intentions and Access to Services as Constraints on Contraceptive Use in Columbia," mimeo, World Bank.

Cochrane, S., O'Hara, D. and J. Leslie 1980. "The Effects of Education on Health," World Bank Staff Working Papers, No. 405. Washington, D.C.: World Bank.

-----. 1982. "Parental Education and Child Health: Intracountry Evidence." Health Policy and Education, 2 (March), 213-250.

Herz, Barbara K. 1984. "Official Development Assistance for Population Activities: A Review." World Bank Staff Working Paper No. 688, Population and Development Series, No. 13. Washington, DC World Bank.

King. E.M. and M.A. Hill. 1991. eds. Women's Education in Developing Countries: Barriers, Benefits and Policy. Johns Hopkins University Press.

Lapham, R.J. and W.P. Mauldin. 1972. "National Family Planning Programs: Reviews and Evaluation." Studies in Family Planning 3:3, 29-52.

Lightbourne, R.E. 1987. "Reproductive Preferences and Behaviour" in Cleland, J., Scott, C. and D. Whitelegge. eds. 1987. The World Fertility Survey - An Assessment. Oxford University Press.

Mauldin, W.P. and J.A. Ross. 1991. "Family Planning Programs: Efforts and Results, 1982-89." Studies in Family Planning, 22:6 (Nov./Dec.), 350-367.

Mensch, B., Lentzner, H. and S. Preston. 1986. Socio-Economic Differentials in Child Mortality in Developing Counties. New York: United Nations.

Preston, S.H. 1980. "Causes and Consequences of Mortality in Less Developed Countries During the Twentieth Century," in Population and Economic Change in Developing Countries, R. Easterlin, ed. New York: National Bureau of Economic Research, 289-360.

-----. 1985. "Mortality and Development Revisited," Population Bulletin of the United Nations, No. 18. New York: United Nations.

Rosenzweig, Mark R. and T.P. Schultz. 1987. "Fertility and Investments in Human Capital: Estimates of the Consequences of Imperfect Fertility Control in Malaysia," Journal of Econometrics 36 (1-2): 163-184.

Ross, J.A., Mauldin, W.P., Green, S.R. and E.R. Cooke. 1992. Family Planning and Child Survival Programs as Assessed in 1991. New York: The Population Council.

Schultz, T.P. 1988. "The Relationship Between Local Family Planning Expenditures and Fertility in Thailand, 1976-1981," paper presented at the Baltimore, MD Annual Meetings of the Population Association of America, March 1989.

——. 1989 "Returns to Women's Education." PHRWD Working Paper No. 001. Washington, DC: World Bank.

——. 1990. "Assessing Family Planning Cost-Effectiveness: Applicability of Individual Demand-Program Supply Framework," mimeo, Economics Department, Yale University.

——. 1992. "Investments in the Schooling and Health of Women and Men: Quantities and Returns," paper presented at the Conference on Women's Human Capital and Development, Bellagio, Italy, May 18-22, 1992.

Summers, R. and A. Heston. 1991. "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988," The Quarterly Journal of Economics, CVI:2 (May), 327-368.

UNDP. 1990. Human Development Report 1990. New York: United Nations.

United Nations. 1991. "Levels and Trends of Contraceptive Use," in "United Nations Women's Indicators and Statistics Spreadsheet Database for Microcomputers" (WISTAT), Version 2. New York: United Nations.

Wheeler, D. 1980. "Female Education, Family Planning, Income and Population: A Long-Run Econometric Simulation Model," in N. Birdsall, ed. "The Effects of Family Planning Programs on Fertility in the Developing World," World Bank Staff Working Papers No. 677, Population and Development Series No. 2, 116-206. Washington, DC: The World Bank.

World Bank. 1989. Sustainable Growth with Equity: Sub-Saharan Africa. Washington, D.C.: World Bank.

World Bank. 1990. World Development Report. Washington, D.C.: World Bank.

World Bank. 1992. Social Indicators of Development (STARS).

World Bank Economic and Social Database (BESD).

World Fertility Survey and United Nations, Department of International Economics and Social Affairs. 1987. Fertility Behaviour in the Context of Development - Evidence from the World Fertility Survey. Population Studies Series No. 100. New York: United Nations.

Appendices

Table A1. List of Sample Countries

Sample n = 72		
Low Income n = 37	Lower Middle Income n = 27	Upper Middle Income n = 8
Afghanistan[1/2/]	Bolivia[2/]	Algeria
Bangladesh[1/]	Botswana	Brazil
Benin	Cameroon[1/2/]	Iran, Islamic Rep.
Burkina Faso	Chile	Iraq
Burma	Colombia	Korea, Rep. of
Burundi	Costa Rica	Panama
Central African Rep.	Cote d'Ivoire	Trinidad and Tobago
Chad[2/]	Ecuador	Venezuela
China[1/]	Egypt, Arab Rep.	
Ethiopia	El Salvador	
Ghana	Guatemala	
Guinea	Honduras	
Haiti[1/]	Jamaica	
India	Malaysia	
Indonesia	Mauritius	
Kenya	Mexico	
Lesotho	Morocco	
Liberia	Papua New Guinea	
Malawi[1/]	Paraguay	
Madagascar	Peru	
Mali	Senegal[2/]	
Mauritania[2/]	Syrian Arab Rep.	
Mozambique[1/]	Thailand	
Nepal	Tunisia	
Niger	Turkey	
Nigeria[2/]	Yemen Arab Republic[1/2/]	
Pakistan	Zimbabwe	
Rwanda		
Sierra Leone		
Somalia		
Sri Lanka		
Sudan		
Tanzania		
Togo		
Uganda		
Zaire		
Zambia		

Note: Not all countries were used in all the equations and simulations owing to gaps in the data on certain specific variables as shown below:

1/ Not used in the TFR or IMR equations with 1970 enrollments (n=64).

2/ Not used in the TFR or IMR equations with 1975 enrollments (n=65).

Table A2. Variables and Definitions

Variable	Definition
TFR85	Total fertility rate, 1985, representing the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children at each age in according with prevailing age-specific fertility rates.
IMR85	Infant mortality rate, 1985, defined as the number of infants who die before reaching one year of age, per 1000 live births.
FED70 MED70 FED75 MED75	Gross secondary enrollment rates for females and males, 1970 and 1975 (1988 was used in the contraceptive prevalence equation).
GDP	Gross domestic product per capita, 1985, purchasing power parity adjusted. 1988 used in equation for contraceptive prevalence and desired family size.
PHYS	Population per physician, 1984 (latest year available). The number includes medical assistants as well as registered practitioners.
URB	Urban population, as a percent of total population, 1985.
CP	Contraceptive Prevalence 1988, represents contraceptive use among currently married women for the latest available year (range 1983-89)
SERV	Percent of the maximum service score that a country has, from the service component of Family Program Effort, 1982 (Mauldin and Ross 1991, and Ross et al. 1992). It includes community-based distribution, social marketing, home-visiting workers, etc.
DFS	Desired Family Size, 1983-88, measures "preferred" family size (WFS).
DUMAFR DUMAS DUMLAC	Dummy Regional Variables representing Africa, Asia and LAC.

Table A3. TFR Equations - Means of Standard Deviations

Variables	Mean	Std. Dev.	Mean	Std. Dev.
TFR85	5.40	1.52	5.35	1.57
FemSec70	13.38	12.71		
MalSec70	20.34	13.74		
FemSec75			18.87	16.55
MalSec75			26.74	17.05
GDP PC85	2124.30	1588.0	2114.5	1585.7
Service 82	23.77	20.6	25.48	21.7
Urban 85	37.00	19.62	35.79	20.0
Pop Phy 84	12053.00	15313.0	11851.0	15213.0
Dummy Africa	0.47	0.50	0.45	0.50
Dummy Asia	0.16	0.36	0.18	0.39
Dummy LAC	0.25	0.44	0.25	0.43
n=	64		65	

Table A4. IMR Equations - Means of Standard Deviations

Variables	Mean	Std. Dev.	Mean	Std. Dev.
IMR85	84.38	40.55	84.83	41.8
FemSec70	13.38	12.71		
MalSec70	20.34	13.74		
FemSec75			18.87	16.55
MalSec75			26.74	17.05
Pop Phy 84	12053	15313	11851	15213
Urban 85	37.0	19.62	35.79	20.0
GDP PC85	1985.5	1523.3	1976.2	1520.9
Service 82	23.77	20.6	25.48	21.72
Dummy Africa	0.47	0.50	0.45	0.50
Dummy Asia	0.16	0.37	0.18	0.39
Dummy LAC	0.25	0.44	0.25	0.43
n=	64		65	

Table A5. Education, Family Planning Services, and Total Fertility Rate

Independent Variables	Dependent Variable, TFR, 1985							
	Without interaction (1)		With interaction (2)		Without interaction (3)		With interaction (4)	
	1970				1975			
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Constant	7.678	13.125***	7.303	12.399***	7.324	6.549***	6.597	4.886**
Female Secondary Gross Enrollment, 1970	-0.084	-3.804***	-0.167	-3.532***				
Female Secondary Gross Enrollment[2]	0.001	2.083**	0.002	2.242**				
Female Secondary Gross Enrollment, 1975					-0.055	-2.092***	-0.050	-1.801**
Female Secondary Gross Enrollment[2]					0.0002	0.596**	0.001	1.253
GDP per capita, 1985	-0.0002	-1.414	-0.0002	-1.389	-0.0001	-0.621	-0.0001	-0.270
Family planning service	-0.023	-2.949***	-0.014	-1.007	-0.022	-1.381	-0.0001	-0.004
Fem. Sec. Enrollment FP services			-0.0004	-0.624			-0.001	-1.680*
Urban population as % of total population	-0.005	-0.502	-0.005	-0.492	-0.002	-0.185	-0.002	-0.222
Under 5 mortality rate, 1985	0.001	0.117	0.003	0.200	0.007	0.170	0.018	0.385
Africa Regional Dummy	-0.347	-1.001	-0.290	-0.806	-0.146	-0.388	0.057	0.142
Asia Regional Dummy	-0.850	-1.879*	-0.852	-1.856*	-0.815	-1.127	-0.866	-1.126
LAC Regional Dummy	-0.285	-0.920	-0.323	-1.010	-0.495	-1.502	-0.574	-1.627
R^2	.79		.78		.79		.76	
n	64		64		65		65	

Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.
1/ 2-stage least squares using population per physician to instrument under 5 mortality rate.
2/ Female Secondary Enrollment used in (a) and (b); male enrollment used for (c).

Table A6. Elasticities of TFR with respect to Female Secondary Enrollment and Family Planning Service at Different Levels of Enrollments, and Service

Levels of enrollment/ Levels of service score	Female Education (1970)	Family Planning Services (1970 education equation)	Female Education (1975)	Family Planning Services (1975 education equation)
Mean	-0.359	-0.092	-0.307	-0.096
10	-0.288	-0.039	-0.186	-0.038
20	-0.459	-0.077	-0.320	-0.075
30	-0.513	-0.116	-0.399	-0.113
40	-0.449	-0.155	-0.426	-0.150
50	-0.268	-0.194	-0.399	-0.188
60	-0.031	-0.32	-0.319	-0.225
70	0.447	-0.271	-0.185	-0.263
80	0.900	-0.310	0.001	-0.300
90	1.631	-0.349	0.242	-0.338
100	2.400	-0.388	0.534	-0.375

Source: Computed from equations 1 and 4 in Table 1.
Means: Female Secondary Enrollment Rate 1970: 13%, Family Planning Services 1982: 24%, IMR 84.4.
Means: Female Secondary Enrollment Rate 1975: 19% Family Planning Services 1982, 25%, IMR 84.8.

Table A7. Female Education, GDP per capita, Desired Family Size, and Contraceptive Prevalence

	Dependent Variable, DFS, 1988		Dependent Variable, CP, 1988	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	4.092	7.285***	-10.832	-2.683***
Female Secondary Gross Enrollment, 1975	-0.070	-3.483***	0.926	2.657***
Female Secondary Gross Enrollment^2	0.001	2.704***	-0.010	-1.994**
Male Secondary Gross Enrollment, 1975				
Male Secondary Gross Enrollment^2				
GDP per capita 1988	0.001	2.005**	0.008	3.169***
GDP per capita^2	-0.0000001	-1.733*	-0.000001	-2.615***
Family planning services			0.524	7.352***
Africa Regional Dummy	2.826	6.129***	2.798	0.728
Asia Regional Dummy	-0.362	-0.844	-2.853	-0.652
LAC Regional Dummy	-0.022	-0.046	2.846	0.583
R^2	.74		.82	
n	32		61	

Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

Table A8. Elasticities of Contraceptive Prevalence, with respect to Female Secondary School Enrollment Rate, Access to Family Planning Services, and GDP per capita, at Different Levels of Enrollment, Access and Income

Range SSE and Access Services = 0-100	Female Secondary School Enrollment Rate in 1975	Access to Family Planning Services, 1982	Range GDP= 300-3000	GDP per capita, 1988
10	0.239	0.172	300	0.075
20	0.349	0.343	600	0.143
30	0.330	0.515	900	0.205
40	0.182	0.687	1200	0.260
50	-0.095	0.858	1500	0.308
60	-0.500	1.030	1800	0.351
70	-1.035	1.201	2100	0.387
80	-1.699	1.373	2400	0.416
90	-2.491	1.545	2700	0.439
100	-3.413	1.717	3000	0.455

Source: Computed from Table 3.
(Means: Female Secondary Enrollment 1975: 20.3%, Access to Services: 28%, GDP per capita: $2324, and CP)

Table A9. Elasticities of IMR with respect to Female Secondary Enrollments, Population per Physician, and GDP at Different Levels of Enrollment, 1975

	Female Education	Population per Physician		GDP per capita	
Enrollment levels		Range 28.000-1.000		Range $300-$4800	
Mean	-0.563	Mean	0.094	Mean	-0.234
10	-0.327	28,000	0.230	300	-0.036
20	-0.590	25,000	0.205	800	-0.095
30	-0.786	22,000	0.181	1300	-0.154
40	-0.918	19,000	0.156	1800	-0.213
50	-0.984	16,000	0.131	2300	-0.272
60	-0.985	13,000	0.107	2800	-0.332
70	-0.921	10,000	0.082	3300	-0.391
80	-0.792	7,000	0.058	3800	-0.450
90	-0.597	4,000	0.033	4300	-0.509
100	0.337	1,000	0.008	4800	-0.568

Source: Computed from equation2 in Table 4.
(Means: Female Gross Enrollment Rate 1975, 20%; Population per Physician 1984, 118511, GDP per capita 1985, $2042, IMR 84.8)

Table A10. Education, Program Variables and Infant Mortality

Independent Variables	Dependent Variable, IMR85			
	(1)		(2)	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	124.601	5.170**	128.669	6.072***
Female Secondary Gross Enrollment Rate, 1970	-3.437	-1.496	-2.518	-1.959*
Female Secondary Gross Enrollment Rate^{-2}	0.029	0.886	0.018	1.144
Female Secondary Gross Enrollment Rate, 1975			-2.518	-1.959*
Female Secondary Gross Enrollment Rate^{-2}			0.018	1.144
Contraceptive prevalence	1.171	1.046	0.597	0.805
Population per physician, 1984	0.001	2.549**	0.001	2.447**
Urban population as % of total population	0.833	2.109**	0.681	2.137**
GDP per capita, 1985	-0.019	-2.525**	-0.014	-2.681***
Infants Immunized, 1987	-0.559	-1.851*	-0.376	-1.644
Africa Regional Dummy	-7.452	-0.565	-3.900	-0.349
Asia Regional Dummy	-8.202	-0.540	-9.187	-0.661
LAC Regional Dummy	+3.263	-1.001	-13.291	-1.141
Adjusted R^2	.55		.68	
n	62		63	

Absolute values of t-ratios, where *, ** and *** indicate significance levels of 10, 5, and 1 percent respectively.

Table A11. Infant Mortality (1985), Female Education and Program Variables, including Immunization

Independent Variables	Dependent Variable, IMR 1985			
	(1) Enrollments 1970		(2) Enrollments 1975	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	107.953	6.544***	119.842	6.344***
Female Secondary Gross Enrollment Rate, 1970	-3.151	-2.142**		
Female Secondary Gross Enrollment Rate squared	0.020	0.894		
Male Secondary Gross Enrollment Rate, 1970	1.437	1.495		
Male Secondary Gross Enrollment Rate squared	-0.01	-0.343		
Female Secondary Gross Enrollment Rate, 1975			-2.853	-3.380***
Female Secondary Gross Enrollment Rate squared			0.013	1.082
Male Secondary Gross Enrollment Rate, 1975			0.329	0.518
Male Secondary Gross Enrollment Rate squared			0.012	1.408
% Infants Immunized, 1987	-0.297	-1.981**	-0.249	-1.663*
Family planning services	-0.123	-0.992	-0.098	-0.788*
Population per physician, 1984	0.001	3.100**	0.001	2.652***
Urban population as % of total population	0.359	1.473	0.312	1.257
GDP per capita, 1985	-0.011	-4.016***	-0.010	-3.517***
Africa Regional Dummy	7.235	0.909	8.250	1.228
Asia Regional Dummy	2.715	0.275	1.875	0.186
LAC Regional Dummy	14.432	1.276	15.281	1.908*
Adjusted R^2	.76		.78	
n=	64		65	

Absolute values of t-ratios, where *, **, and *** indicate significance levels of 10, 5, and 1 percent respectively.

Distributors of World Bank Publications

ARGENTINA
Carlos Hirsch, SRL
Galeria Guemes
Florida 165, 4th Floor-Ofic. 453/465
1333 Buenos Aires

AUSTRALIA, PAPUA NEW GUINEA, FIJI, SOLOMON ISLANDS, VANUATU, AND WESTERN SAMOA
D.A. Books & Journals
648 Whitehorse Road
Mitcham 3132
Victoria

AUSTRIA
Gerold and Co.
Graben 31
A-1011 Wien

BANGLADESH
Micro Industries Development Assistance Society (MIDAS)
House 5, Road 16
Dhanmondi R/Area
Dhaka 1209

Branch office:
156, Nur Ahmad Sarak
Chittagong 4000

74, K.D.A. Avenue
Kulna 9100

BELGIUM
Jean De Lannoy
Av. du Roi 202
1060 Brussels

CANADA
Le Diffuseur
C.P. 85, 1501B rue Ampère
Boucherville, Québec
J4B 5E6

CHILE
Invertec IGT S.A.
Americo Vespucio Norte 1165
Santiago

CHINA
China Financial & Economic Publishing House
8, Da Fo Si Dong Jie
Beijing

COLOMBIA
Infoenlace Ltda.
Apartado Aereo 34270
Bogota D.E.

COTE D'IVOIRE
Centre d'Edition et de Diffusion Africaines (CEDA)
04 B.P. 541
Abidjan 04 Plateau

CYPRUS
Center of Applied Research
Cyprus College
6, Diogenes Street, Engomi
P.O. Box 2006
Nicosia

DENMARK
SamfundsLitteratur
Rosenoerns Allé 11
DK-1970 Frederiksberg C

DOMINICAN REPUBLIC
Editora Taller, C. por A.
Restauración e Isabel la Católica 309
Apartado de Correos 2190 Z-1
Santo Domingo

EGYPT, ARAB REPUBLIC OF
Al Ahram
Al Galaa Street
Cairo

The Middle East Observer
41, Sherif Street
Cairo

FINLAND
Akateeminen Kirjakauppa
P.O. Box 128
SF-00101 Helsinki 10

FRANCE
World Bank Publications
66, avenue d'Iéna
75116 Paris

GERMANY
UNO-Verlag
Poppelsdorfer Allee 55
D-5300 Bonn 1

HONG KONG, MACAO
Asia 2000 Ltd.
46-48 Wyndham Street
Winning Centre
2nd Floor
Central Hong Kong

INDIA
Allied Publishers Private Ltd.
751 Mount Road
Madras - 600 002

Branch offices:
15 J.N. Heredia Marg
Ballard Estate
Bombay - 400 038

13/14 Asaf Ali Road
New Delhi - 110 002

17 Chittaranjan Avenue
Calcutta - 700 072

Jayadeva Hostel Building
5th Main Road, Gandhinagar
Bangalore - 560 009

3-5-1129 Kachiguda
Cross Road
Hyderabad - 500 027

Prarthana Flats, 2nd Floor
Near Thakore Baug, Navrangpura
Ahmedabad - 380 009

Patiala House
16-A Ashok Marg
Lucknow - 226 001

Central Bazaar Road
60 Bajaj Nagar
Nagpur 440 010

INDONESIA
Pt. Indira Limited
Jalan Borobudur 20
P.O. Box 181
Jakarta 10320

IRELAND
Government Supplies Agency
4-5 Harcourt Road
Dublin 2

ISRAEL
Yozmot Literature Ltd.
P.O. Box 56055
Tel Aviv 61560

ITALY
Licosa Commissionaria Sansoni SPA
Via Duca Di Calabria, 1/1
Casella Postale 552
50125 Firenze

JAPAN
Eastern Book Service
Hongo 3-Chome, Bunkyo-ku 113
Tokyo

KENYA
Africa Book Service (E.A.) Ltd.
Quaran House, Mfangano Street
P.O. Box 45245
Nairobi

KOREA, REPUBLIC OF
Pan Korea Book Corporation
P.O. Box 101, Kwangwhamun
Seoul

MALAYSIA
University of Malaya Cooperative Bookshop, Limited
P.O. Box 1127, Jalan Pantai Baru
59700 Kuala Lumpur

MEXICO
INFOTEC
Apartado Postal 22-860
14060 Tlalpan, Mexico D.F.

NETHERLANDS
De Lindeboom/InOr-Publikaties
P.O. Box 202
7480 AE Haaksbergen

NEW ZEALAND
EBSCO NZ Ltd.
Private Mail Bag 99914
New Market
Auckland

NIGERIA
University Press Limited
Three Crowns Building Jericho
Private Mail Bag 5095
Ibadan

NORWAY
Narvesen Information Center
Book Department
P.O. Box 6125 Etterstad
N-0602 Oslo 6

PAKISTAN
Mirza Book Agency
65, Shahrah-e-Quaid-e-Azam
P.O. Box No. 729
Lahore 54000

PERU
Editorial Desarrollo SA
Apartado 3824
Lima 1

PHILIPPINES
International Book Center
Suite 1703, Cityland 10
Condominium Tower 1
Ayala Avenue, Corner H.V. dela Costa Extension
Makati, Metro Manila

POLAND
International Publishing Service
Ul. Piekna 31/37
00-677 Warszawa

For subscription orders:
IPS Journals
Ul. Okrezna 3
02-916 Warszawa

PORTUGAL
Livraria Portugal
Rua Do Carmo 70-74
1200 Lisbon

SAUDI ARABIA, QATAR
Jarir Book Store
P.O. Box 3196
Riyadh 11471

SINGAPORE, TAIWAN, MYANMAR, BRUNEI
Information Publications Private, Ltd.
Golden Wheel Building
41, Kallang Pudding, #04-03
Singapore 1334

SOUTH AFRICA, BOTSWANA
For single titles:
Oxford University Press Southern Africa
P.O. Box 1141
Cape Town 8000

For subscription orders:
International Subscription Service
P.O. Box 41095
Craighall
Johannesburg 2024

SPAIN
Mundi-Prensa Libros, S.A.
Castello 37
28001 Madrid

Libreria Internacional AEDOS
Consell de Cent, 391
08009 Barcelona

SRI LANKA AND THE MALDIVES
Lake House Bookshop
P.O. Box 244
100, Sir Chittampalam A. Gardiner Mawatha
Colombo 2

SWEDEN
For single titles:
Fritzes Fackboksforetaget
Regeringsgatan 12, Box 16356
S-103 27 Stockholm

For subscription orders:
Wennergren-Williams AB
P. O. Box 1305
S-171 25 Solna

SWITZERLAND
For single titles:
Librairie Payot
1, rue de Bourg
CH 1002 Lausanne

For subscription orders:
Librairie Payot
Service des Abonnements
Case postale 3312
CH 1002 Lausanne

TANZANIA
Oxford University Press
P.O. Box 5299
Maktabe Road
Dar es Salaam

THAILAND
Central Department Store
306 Silom Road
Bangkok

TRINIDAD & TOBAGO, ANTIGUA BARBUDA, BARBADOS, DOMINICA, GRENADA, GUYANA, JAMAICA, MONTSERRAT, ST. KITTS & NEVIS, ST. LUCIA, ST. VINCENT & GRENADINES
Systematics Studies Unit
#9 Watts Street
Curepe
Trinidad, West Indies

TURKEY
Infotel
Narlabahçe Sok. No. 15
Cagaloglu
Istanbul

UNITED KINGDOM
Microinfo Ltd.
P.O. Box 3
Alton, Hampshire GU34 2PG
England

VENEZUELA
Libreria del Este
Apdo. 60.337
Caracas 1060-A

Recent World Bank Discussion Papers *(continued)*

No. 164 *How Do National Policies Affect Long-run Growth?: A Research Agenda*. William Easterly, Robert King, Ross Levine, and Sergio Rebelo

No. 165 *Fisheries Development, Fisheries Management, and Externalities*. Richard S. Johnston

No. 166 *The Building Blocks of Participation: Testing Bottom-up Planning*. Michael M. Cernea

No. 167 *Seed System Development: The Appropriate Roles of the Private and Public Sectors*. Steven Jaffee and Jitendra Srivastava

No. 168 *Environmental Management and Urban Vulnerability*. Alcira Kreimer and Mohan Munasinghe, editors

No. 169 *Common Property Resources: A Missing Dimension of Development Strategies*. N. S. Jodha

No. 170 *A Chinese Province as a Reform Experiment: The Case of Hainan*. Paul M. Cadario, Kazuko Ogawa, and Yin-Kann Wen

No. 171 *Issues for Infrastructure Management in the 1990s*. Arturo Israel

No. 172 *Japanese National Railways Privatization Study: The Experience of Japan and Lessons for Developing Countries*. Koichiro Fukui

No. 173 *The Livestock Sector in Eastern Europe: Constraints and Opportunities*. Cornelis de Haan, Tjaart Schillhorn Van Veen, and Karen Brooks

No. 174 *Assessing Development Finance Institutions: A Public Interest Analysis*. Jacob Yaron

No. 175 *Resource Management and Pastoral Institution Building in the West African Sahel*. Nadarajah Shanmugaratnam, Trond Vedeld, Anne Mossige, and Mette Bovin

No. 176 *Public and Private Sector Roles in Agricultural Research: Theory and Experience*. Dina L. Umali

No. 177 *The Regulatory Impediments to the Private Industrial Sector Development in Asia: A Comparative Study*. Deena Khatkhate

No. 178 *China: Reforming Intergovernmental Fiscal Relations*. Ramgopal Agarwala

No. 179 *Nippon Telegraph and Telephone Privatization Study: Experience of Japan and Lessons for Developing Countries*. Yoshiro Takano

No. 180 *China's Reform Experience to Date*. Peter Harrold

No. 181 *Combatting AIDS and Other Sexually Transmitted Diseases in Africa: A Review of the World Bank's Agenda for Action*. Jean-Louis Lamboray and A. Edward Elmendorf

No. 182 *Privatization Problems at Industry Level: Road Haulage in Central Europe*. Esra Bennathan and Louis S. Thompson

No. 183 *Participatory Development and the World Bank: Potential Directions for Change*. Bhuvan Bhatnagar and Aubrey C. Williams, editors

No. 184 *Agricultural Research in Southern Africa: A Framework for Action*. Andrew Spurling, Teck Y. Pee, Godwin Mkamanga, and Christopher Nkwanyana

No. 185 *Military Expenditure and Economic Development: A Symposium on Research Issues*. edited by Geoffrey Lamb with Valeriana Kallab

No. 186 *Efficiency and Substitution in Pollution Abatement: Three Case Studies*. Dennis Anderson and William Cavendish

No. 187 *The State Holding Company: Issues and Options*. Anjali Kumar

No. 188 *Indigenous Views of Land and the Environment*. Shelton H. Davis, editor

No. 189 *Poverty, Population, and the Environment*. Stephen D. Mink

No. 190 *Natural Gas in Developing Countries: Evaluating the Benefits to the Environment*. John Homer

No. 191 *Appropriate Macroeconomic Management in Indonesia's Open Economy*. Sadiq Ahmed

No. 192 *Telecommunications: World Bank Experience and Strategy*. Bjorn Wellenius and others

No. 193 *Information Systems Strategies for Public Financial Management*. Hywel M. Davies, Ali Hashim, and Eduardo Talero

The World Bank

Headquarters
1818 H Street, N.W.
Washington, D.C. 20433, U.S.A.

Telephone: (202) 477-1234
Facsimile: (202) 477-6391
Telex: WUI 64145 WORLDBANK
RCA 248423 WORLDBK
Cable Address: INTBAFRAD
WASHINGTONDC

European Office
66, avenue d'Iéna
75116 Paris, France

Telephone: (1) 40.69.30.00
Facsimile: (1) 40.69.30.66
Telex: 640651

Tokyo Office
Kokusai Building
1-1 Marunouchi 3-chome
Chiyoda-ku, Tokyo 100, Japan

Telephone: (3) 3214-5001
Facsimile: (3) 3214-3657
Telex: 26838

ISBN 0-8213-2387-3